THE ROLE OF LUMBAR SPINE X-RAYS IN THE DIAGNOSIS AND MANAGEMENT OF PATIENTS WHO PRESENT WITH LOW BACK PAIN

By

Sarah M^{c}Phail

Dissertation submitted in partial compliance with the requirements for the Master's Degree in Technology: Chiropractic

Durban University of Technology

I, Sarah M^{c}Phail, do hereby declare that this dissertation is representative of my own work in both conception and execution (except where acknowledgements indicate to the contrary)

……..... Date: ……

Sarah M^{c}Phail

Approved for Final Submission

…….. Date: ……

Dr. J. Shaik
M. Tech. Chiro., M. Med. Sci. (SM), MCASA

DEDICATION

I dedicate this dissertation to:

My parents, Bruce and Debbie M^{c}Phail, my boyfriend Justin, my grandparents, my sister and my special friends.

Thank you for your love, support and patience throughout my academic career. I would not be where I am today without your influence.

"Whatever is good to know is difficult to learn"
Greek Proverb

ACKNOWLEDGEMENTS

It is with sincere gratitude and appreciation that I would like to thank the following people:

1. My supervisor, Dr. J. Shaik, of the Department of Chiropractic, Faculty of Health Sciences, Durban University of Technology, for his support and guidance throughout this entire research process. I would not have been able to produce this dissertation without your invaluable help.

2. Mrs. Tonya Esterhuizen for her assistance with the statistical analyses used in this study.

3. The Durban University of Technology for providing partial funding towards the research costs of this study.

ABSTRACT

Background:

Low back pain is a common condition and affects most people at least once in their lives. The causes of low back pain (LBP) are numerous and may include non-specific mechanical causes, or specific causes which may be of a more serious nature. Researchers have tried to link specific history and physical examination findings with certain disorders, but as of yet, have been unsuccessful. Research has shown that x-rays may be over utilized and the guidelines for referral are not always adhered to. Furthermore, there is a paucity of literature on the role of x-rays in influencing the management of patients with low back pain.

Objectives:

The objectives of this retrospective study were: 1) to determine the relationship between the clinical and the radiographic diagnoses of patients with LBP, 2) to record the consultation at which a lumbar spine x-ray was requested by the student or clinician and the reasons thereof, 3) to record the suspected clinical diagnoses and management of the selected patients prior to referral for lumbar spine x-rays, 4) to determine the number of incidental radiographic findings in the selected patients' x-rays, and 5) to determine any change in the clinical diagnoses and management following radiographic reporting of the selected patients' x-rays.

Method:

The Chiropractic Day Clinic (CDC) at the Durban University of Technology (DUT) archives were searched for lumbar spine radiographs and the corresponding patient files of patients who presented with LBP from 1 January 1997 to 31 July 2010. Data collection was in a stepwise process with the anteroposterior and lateral lumbar spine x-rays being read first, without any knowledge of the patient's main complaint and then the corresponding patient files were evaluated and selected clinical variables were recorded. Statistical analysis included the use of frequency counts, percentages, mean, standard deviation and range for the descriptive objectives. Diagnoses were categorized into specific groups and indicator variables were used to construct two-by-two tables of absence or presence of radiographic vs. clinical diagnosis for each specific diagnosis to determine any possible associations.

Results:

The mean age of the patients was 43.9 (± 16.9) years and the number of male and female patients were 40 and 34 respectively. It was not possible to correlate the clinical and radiographic diagnoses because the categories were too different for any statistical test to be performed. Spondylosis was the most common radiographic finding. The majority of the lumbar spine x-rays were requested at the first consultation. No suitable reason for obtaining the x-ray was provided in 14.6% of the x-rays requested and 20.7% were requested to examine for an unspecified pathology. Of the 74 patients in this study, 44 patients did not have a change in diagnosis, which means that 59.5% of the diagnoses stayed the same after x-ray examination. However, in 30 (40.5%) of cases the clinical diagnosis was changed following x-ray examination. This may indicate an overuse of x-rays at the CDC. Most patients were diagnosed with the non specific mechanical causes of low back pain. A wide range of treatment modalities were utilized both before and after x-rays were taken, including soft tissue therapies, electrotherapies and spinal manipulation. Following x-ray imaging there was a greater use of spinal manipulation ie. 62% versus only 39% of cases prior to imaging.

Conclusion:

Lumbar spine x-rays may be over utilised at the CDC but their findings were influential in the diagnosis and management in 30 (40.5%) of the patients. The majority of the clinical diagnoses were of the mechanical or non-specific causes of low back pain.

LIST OF DEFINITIONS

Degeneration:	Progressive, age-related degenerative changes of the spine (Thomas, 2004) (used interchangeably with spondylosis)
Incidental findings:	Any abnormality not related to the illness or causes that prompted the diagnostic imaging test (Lumbreras *et al.*, 2010)
Low back pain:	Pain or other related symptoms, such as stiffness or discomfort, in the region located from the lower costal margins to the gluteal folds (Ammendolia *et al.*, 2007; Louw *et al.*, 2007)
Lumbar facet syndrome:	Hypertrophic changes in the zygapophyseal or facet joints, which are secondary to osteoarthritis of these joints, could cause entrapment of lumbar nerve roots and hence low back pain (Malanga and Chimes, 2008)
Pelvic blocking:	A type of sacroiliac joint mobilization in which the motion is restored to the joint (Stedman's Medical Dictionary, 2005)
Radicular-type pain:	Pain along the pathway of a spinal nerve (Stedman's Medical Dictionary, 2005)
Sacroiliac syndrome:	Pain originating from a dysfunctional sacroiliac joint (Cohen, 2005)
Spondylosis:	Ankylosis of the vertebra; and is a term that is often applied non-specifically to any degenerative lesion of the spine (Stedman's Medical Dictionary, 2005) (used interchangeably with degeneration)

LIST OF ABBREVIATIONS AND SYMBOLS

ABCS	Alignment, bone, cartilage and soft tissue
AP	Antero-posterior
APS	Action potential stimulation
CAM	Complementary and alternative medicine
CDC	Chiropractic Day Clinic
cm	Centimeters
CT	Computed tomography
DISH	Diffuse idiopathic skeletal hyperostosis
DUT	Durban University of Technology
ESR	Erythrocyte sedimentation rate
FBC	Full blood count
HIV	Human immunodeficiency virus
IBD	Inflammatory bowel disease
IFC	Interferential current therapy
IVD	Intervertebral disc
LBP	Low back pain
MFPD	Myofascial pain and dysfunction
MRI	Magnetic resonance imaging
n	Sample size or count
NRE	Nerve root entrapment
NSAID	Non-steroidal anti-inflammatory drug
OA	Osteoarthritis
p	Probability
PNF	Proprioceptive neuromuscular facilitation
SD	Standard deviation
SI	Sacroiliac
SOAPE	Subjective, objective, assessment, plan and education
SPSS	Statistical Package for the Social Sciences
TB	Tuberculosis
TENS	Transcutaneous electrical nerve stimulation
viz.	Namely
yrs	Years

°C	Degrees celcius
±	Plus or minus
>	Greater than
≥	Greater than or equal to
≤	Less than or equal to
<	Less than
✓	Modality was used in treatment
×	Modality was not used in treatment

LIST OF TABLES

CHAPTER TWO

CHAPTER THREE

CHAPTER FOUR

LIST OF FIGURES

CHAPTER TWO

CHAPTER FOUR

LIST OF APPENDICES

TABLE OF CONTENTS

CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION TO THE STUDY

Low back pain is a common musculoskeletal condition with a lifetime prevalence reported to be about 85% in developed countries and 62% in Africa (Louw *et al.*, 2007). Although most cases of low back pain are benign, a few cases are caused by serious pathology which needs to be considered in the differential diagnosis (Jarvik and Deyo, 2002). A medical history and physical examination can identify possible causes of low back pain, determine the necessity of diagnostic tests and guide the initial treatment programme. This may lead to the detection of 'red flags' which indicate a serious disease which warrant a more detailed examination (Atlas and Nardin, 2003).

Chiropractors have been utilising radiographs to assist in the diagnosis of their patients almost since the discovery of ionizing radiation in 1895 (Peterson and Hsu, 2005). While important radiographic information may be obtained from spinal radiographs (Beck *et al.*, 2004), they should be interpreted in the context of the patient's clinical findings (Atlas and Nardin, 2003). An x-ray should only be ordered if there is clinical justification and if the findings will influence the management of the patient (Peterson and Hsu, 2005). The identification of certain radiographic findings is of great use when deciding on a treatment protocol and the further management of the patient (Sherman, 1986). X-rays influence three areas of patient care viz. the diagnosis, treatment and prognosis (Shanks, 1992). The management of the patient could change according to what is observed on the x-ray as it may verify the clinical diagnosis and determine the treatment protocol. Occasionally the identification of an incidental finding will require an alteration in the treatment protocol which could include referral to another practitioner (Beck *et al.*, 2004).

Any radiographic abnormality must always be interpreted in the context of each patient's clinical syndrome (Atlas and Nardin, 2003). Scavone *et al.* (1981) reported that sensory and motor deficits were clinical features that have a good correlation with radiographic

findings of the lumbar spine. However, a later study by Atlas and Nardin (2003) reported that one of the limitations of plain film radiography as an investigative tool for the diagnosis of low back pain is that the radiographic findings correlated poorly with the symptoms of low back pain. These conflicting observations emphasise the need to investigate the relationship between radiographic and clinical diagnoses of low back pain. Furthermore, none of these studies reported on the impact of the radiographic diagnosis on alterations to the management of the patient.

Ammendolia *et al.* (2007) reported that some chiropractors overuse x-rays, especially for low back pain, even though this goes against medical evidence-based guidelines (Simmons *et al.*, 1995). This overuse is seen particularly in cases of acute low back pain, when screening for contraindications to manipulation and to avoid cases of malpractice (Ammendolia *et al.* 2007). This accusation is not specific to the chiropractic profession, as medical practitioners have also been observed to be unreasonably referring for x-rays. Scavone *et al.* (1981) observed that repeat x-rays in particular are overused, with 64% showing no change and 32% showing the expected healing or degenerative processes.

Research conducted at a university teaching hospital evaluated the use of lumbar spine films by the oncology referral centre (Scavone *et al.,* 1981). The researchers correlated patients' history and physical examination findings with four groups of radiological findings. They observed that at their institution, in more than 50% of lumbar spine x-rays no pathologies or incidental findings were found. According to them this high percentage of unproductive studies indicated an overuse of x-rays at their hospital.

In conclusion, the discrepancies in the observations of Scavone *et al.* (1981) and Atlas and Nardin (2003) and the reported overuse of x-rays (Scavone *et al.*, 1981; Ammendolia *et al.*, 2007) highlight the need to determine the relationship between the radiographic diagnosis and clinical diagnosis of low back pain as this will aid in the judicious ordering of x-rays. It is also important to not only investigate the role of x-rays in determining the treatment protocol but also how the x-ray findings may guide the practitioner in determining a change in the treatment or management protocol.

1.2 AIMS AND OBJECTIVES

1.2.1 THE AIMS OF THE STUDY:

The aims of this study were to determine the relationship between the clinical and the radiographic diagnoses of patients who present with low back pain at a chiropractic teaching clinic, and whether lumbar spine x-rays influence a change in the diagnosis or management of these patients.

1.2.2 THE OBJECTIVES OF THE STUDY:

Specific objectives were identified and these included:

a) To determine the relationship between the clinical and the radiographic diagnoses of patients with low back pain.

b) To record the consultation at which a lumbar spine x-ray was requested by the student or clinician and the reasons thereof.

c) To record the suspected clinical diagnoses[1] and management of the selected patients prior to referral for lumbar spine x-rays.

d) To determine the number of incidental radiographic findings in the selected patients' x-rays.

e) To determine any change in the clinical diagnoses[1] and management following radiographic reporting of the selected patients' x-rays.

[1] This refers to the clinical suspicion as it appears either on the SOAPE note or the radiographic request form at the point of referral for x-rays.

1.3 SCOPE OF THE STUDY

The results of 74 lumbar spine x-rays and the corresponding patient files which satisfied the inclusion and exclusion criteria are discussed in this dissertation. Purposive sampling was used and all x-rays and patient files were found in the Durban University of Technology (DUT) Chiropractic Day Clinic (CDC) archives. Informed consent was already obtained from each patient for their clinical and radiographic records to be utilised for research purposes at their initial consultation. Confidentiality was maintained at all times by assigning a code to each patient which was used instead of the actual patients' names and by limiting access of the files and x-rays to only the researcher and the research supervisor. Lumbar spine x-rays and the corresponding patient files were examined by the researcher and confirmed by the supervisor, and the selected radiographic and clinical findings were recorded.

1.4 LIMITATIONS OF THE STUDY

This study was limited to lumbar spine x-rays and corresponding patient files within the CDC archives. In this study, x-rays were needed to be taken at some point in the patient's treatment or management at the CDC. This excluded any patients with low back pain who presented with lumbar spine x-rays at the initial consultation. The reason being that it cannot be determined if the x-ray findings would influence a change in the diagnosis or management of the patient if they were taken prior to the first visit at the CDC.

As this study was retrospective, it was limited to the details already recorded in the patient files and there was no way of verifying or clarifying the history or examination findings. Different examiners will interpret history or physical examination findings differently and so may choose to leave some information out of the documentation. This study was probably not representative of all the low back pain patients at the CDC. This was due to many patients taking their x-rays home with them and some x-rays had been removed from the archives for test and examination purposes for the students.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION TO LOW BACK PAIN

Low back pain is defined as pain experienced in the lumbar region of the spine, or in the lumbosacral spinal and paraspinal regions (Atlas and Nardin, 2003). Another recent definition of low back pain is pain or other related symptoms, such as stiffness or discomfort, in the region located from the lower costal margins to the gluteal folds (Ammendolia *et al.*, 2007; Louw *et al.*, 2007).

The symptoms of low back pain may be acute, lasting less than four weeks; subacute, lasting from four to 12 weeks; or chronic, lasting longer than 12 weeks. Chronic pain may be further divided into persistent pain or multiple recurrences of acute pain (Atlas and Nardin, 2003). The natural history of acute low back pain is characterised by a moderately severe functional disability at the onset of the symptoms with a relatively rapid clinical improvement (Carey and Garrett, 1996), but chronic low back pain may have a more insidious onset with an episodic nature from which some patients recover, some experience repeated episodes, and others experience continuous symptoms for years (Dunn and Croft, 2004).

Low back pain is a common musculoskeletal condition and is a prominent problem for medical practitioners as most patients will have at least one episode at some point in their lives (Atlas and Nardin, 2003). The lifetime prevalence of low back pain is reported to be about 85% in developed countries and 62% in Africa and it has been observed that the prevalence of low back pain is rising in Africa. The point prevalence of low back pain in South Africa is 14% in adolescents and 25% in adults and it has been reported that the point prevalence increases with age (Louw *et al.*, 2007). Traditionally, patients suffering from low back pain seek medical treatment but recently it has been reported that more patients are seeking care from alternative health care providers, including chiropractors, for the management of their low back pain (Atlas and Nardin, 2003).

2.1.1 LOW BACK PAIN AND CHIROPRACTIC

Chiropractic has grown to be the second largest non-medical health-care profession since it was founded in 1895 (Pedersen *et al.*, 1992). It has been found that the primary area of complaint encountered by chiropractors is related to the low back (Souza, 2009). Pedersen *et al.* (1992) reported that 34.3% of main complaints involve low back pain with or without radiation, versus 9.8% in the cervical spine, 7.8% in the extremities and 0.9% in the thoracic spine.

The Canadian Memorial Chiropractic College conducted a study to determine the demographic profile of their patients and to compare this to other chiropractic teaching colleges and to private practice (Waalen *et al.*, 1994). They found that the number of male and female patients was approximately equal. The median age of patients receiving treatment was 28 years, with a range of 1 to 93 years. The average age for American patients who present at private practitioners (chiropractors) was 46 years, but younger patients were more likely to be treated at American Chiropractic Colleges as the average age of patients at these institutions was 36.5 years. Contrary to popular reports, the lumbar region was found to be the second most common area of complaint at their clinic, after the cervical region. The 1991 Rand Health Study on the other hand, reported low back pain as the most common complaint, with similar findings observed in other chiropractic colleges (Waalen *et al.*, 1994).

2.2 THE AETIOLOGY AND DIAGNOSIS OF LOW BACK PAIN

According to McCulloch and Transfeldt (1997), the causes of low back pain may be classified into two broad categories as shown in **Table 2.1**.

Table 2.1 Classification of low back pain*

Spinal causes	**Non-spinal causes**
Spondylogenic	Viscerogenic
Neurogenic	Vascular
	Psychogenic

*Adapted from McCulloch and Transfeldt (1997)

Low back pain may have spinal or non-spinal causes (**Table 2.1**). The spondylogenic or spinal causes include lesions involving the bones of the spinal column, the sacroiliac joints and changes in the intervertebral discs, ligaments, muscles and other soft tissues of the lumbosacral spinal region as shown in **Table 2.2**. The spondylogenic category encompasses the most common causes of low back pain that are usually seen in clinical practice. The neurogenic causes include any disorders resulting in tension, compression or irritation of the lumbar nerve roots that usually results in radicular-type pain in one or both of the patient's legs and is commonly as a result of a lumbar intervertebral disc herniation. However, lesions of the central nervous system and tumours of the nerve roots should also be taken into account as they may often mimic an intervertebral disc herniation. Viscerogenic causes include disorders of the kidneys, pelvic viscera and retroperitoneal tumours. In these cases, backache is usually not the sole complaint and the patient will usually complain of other symptoms specific to their particular disorder. Vascular disorders include peripheral vascular disease and abdominal aortic aneurysms and they may present with claudication or a radicular-type pain. However, spinal stenosis may also mimic the claudication of peripheral vascular disease. Although emotional stress may affect a patient's perception of their back pain, pure psychogenic back pain is rarely observed in clinical practice (McCulloch and Transfeldt, 1997).

A more comprehensive classification has been adapted from Atlas and Nardin (2003) and is presented in **Table 2.2**. Pederson *et al.* (1992) described the difficulty of diagnosing musculoskeletal conditions, including low back pain, because of their multi-aetiological and multi-factorial nature as shown in **Tables 2.2** and **2.3**.

Even with the most sophisticated diagnostic procedures the exact lesion responsible for the patient's pain may not be identified. Little is known about the aetiology and pathogenesis of low back pain and as a result most cases of low back pain cannot be diagnosed with certainty (Lutz *et al.*, 2003). Approximately 80% of low back pain patients have non-specific or mechanical low back pain and the remaining 20% have non-mechanical low back pain, which may be due to a serious pathology (Kent and Keating, 2004).

Most cases of low back pain are benign and self-limited, but a few cases are caused by serious pathology which needs to be considered in the differential diagnosis (Jarvik and Deyo, 2002). The presence of a serious condition may drastically alter the treatment and management strategies of the patient (Sherman, 1986). The differential diagnosis of low back pain is presented in **Table 2.2**.

Table 2.2 Differential diagnosis of low back pain*

	Non-mechanical aetiologies		
Mechanical LBP	Spinal disorders	Visceral disorders	Other
Lumbar strain or sprain Lumbar facet syndrome Sacroiliac syndrome Degenerative disease Spondylolysis Spondylolisthesis IVD herniation Spinal stenosis Fracture Traumatic Osteoporotic Congenital disease Severe kyphosis Severe scoliosis Transitional vertebrae Internal IVD disruption (discogenic pain) MFPD	Neoplasia Metastatic carcinoma Primary spinal cord or vertebral tumour Retroperitoneal tumours Infection Osteomyelitis Septic discitis Paraspinal or epidural abscess Herpes zoster Inflammatory arthritis Ankylosing spondylitis Reiter's syndrome Psoriatic spondylitis IBD Paget's disease Scheuermann's disease DISH	Pelvic organs Prostatitis Endometriosis Pelvic inflammatory disease Renal disease Nephrolithiasis Pyelonephritis Perinephric abscess Vascular disease Abdominal aortic aneurysm Aortoiliac disease Gastrointestinal disease Pancreatitis Cholecystitis Perforated bowel	Iatrogenic Failed back surgery syndrome Idiopathic Psychological Depression Stress

*adapted from Atlas and Nardin (2003)

LBP = Low back pain; IVD = intervertebral disc; MFPD = myofascial pain and dysfunction; DISH = diffuse idiopathic skeletal hyperostosis; IBD = inflammatory bowel disease

Mechanical low back pain arises from structural or functional changes in the spine, the surrounding muscles, ligaments, facet joints, nerves, periosteum, blood vessels or intervertebral discs. Low back pain may also be referred from the sacroiliac or hip joints and their musculature. These conditions may be difficult to identify reliably by physical examination or diagnostic testing and so the exact structure causing the pain is often unknown (Kent and Keating, 2004). This difficulty in identifying the causative structure may be even more difficult in chronic low back pain. Some patients may have a persistent mechanical injury, while in others, the initial injury may lead to the generation of pain within the central nervous system, due to a modulation of pain processing pathways (Atlas and Nardin, 2003).

Spondylosis is a term that is often applied non-specifically to any degenerative lesion of the spine (Stedman's Medical Dictionary, 2005). Thomas (2004) refers to spondylosis as progressive, age-related degenerative changes of the spine. Yochum and Rowe (2005) state that there are only two joint complexes in the lumbar spine that undergo degenerative changes and these are the apophyseal joints and the intervertebral discs. van Tulder *et al.* (1997) reported that although the definition of degeneration varied between studies, it was generally defined as the presence of intervertebral disc space narrowing, osteophytes or sclerosis. van Tulder *et al.* (1997) cite definitions by other authors, in which Biering-Sørensen *et al.* (1985) and Horal (1969) define degeneration by

the presence of osteophytosis and sclerosis on the adjacent vertebrae with intervertebral disc space narrowing, and spondylosis by the presence of marginal osteophytes on the vertebral bodies. van Tulder *et al.* (1997) also cite the definition used by Hussar and Guller (1956), which defines spondylosis as the presence of osteophytes on the vertebral bodies, intervertebral disc space narrowing and narrowed intervertebral foramina (van Tulder *et al.,* 1997). It appears that authors use the term spondylosis interchangeably with degenerative joint disease, or they do not clearly define their use of these terms leading to confusion as to what disease entity they are referring to. This highlights the problem with the terms degeneration and spondylosis, as their definitions and use is often vague and non-specific.

Spinal stenosis is often considered to be a degenerative condition and is therefore, often seen in older individuals. Stenosis may be caused by bony encroachment, as in the case of facet joint hypertrophy, by soft tissue obstructions, like a herniated intervertebral disc or thickening of the ligamentum flavum, or it may be caused by both of these mechanisms. It has been reported that 20% of patients remain asymptomatic despite signs of stenosis on diagnostic imaging. The classic symptom of spinal stenosis is neurogenic claudication. Neurogenic claudication may be differentiated from vascular claudication in that it is more likely to occur when the patient is just standing, rather than walking. It is commonly associated with paraesthesias in the lower extremity and may be aggravated by coughing or sneezing. The most useful finding is the absence of pain when the patient is seated with the spine flexed (Jarvik and Deyo, 2002).

The term ‘lumbar facet syndrome’ (**Table 2.2**) first appeared in 1933 when Ghormley suggested that hypertrophic changes in the zygapophyseal or facet joints, which were secondary to osteoarthritis of these joints, could cause entrapment of lumbar nerve roots and hence low back pain (Malanga and Chimes, 2008). The lumbosacral facet joints are one of the most common causes of low back pain, contributing almost 80% of all causes of mechanical low back pain. Even though lumbar facet syndrome is so common, it is difficult to diagnose with accuracy as no history or physical examination findings are specific to this condition. Often the findings are usually of a non-specific, deep, achy, paraspinal pain that is poorly localised. It is often confused with discogenic pain as it occasionally produces a referral of pain in a pattern that is indistinguishable from that of an intervertebral disc herniation. The most common referral pattern is for pain to occur in the flank, buttock, iliac crest and groin. The buttock pain often extends into the posterior thigh, but rarely radiates below the knee, which helps to distinguish facet pain from that of an intervertebral disc. It is thought that facet joint degeneration is in fact secondary to

intervertebral disc degeneration. Lumbar facet syndrome may be caused by synovial fold impingement (Gronblad *et al.*, 1991), arthritis within the facet joints, hypertrophy of the joint which may impinge on nearby structures, or during acute rotational and extension injuries. Lumbosacral facet syndrome may also lead to chronic low back pain (Malanga and Chimes, 2008). The sacroiliac joints have a pain sensitivity that is lower than that of the lumber facet joints and as such, dysfunctional sacroiliac joints may be a cause of low back pain (Cohen, 2005).

Sacroiliac syndrome is pain originating from a dysfunctional sacroiliac joint. There is no universally accepted method for diagnosing sacroiliac syndrome and it has been observed that as many as 20% of asymptomatic individuals may have positive sacroiliac provocation tests (Cohen, 2005). The symptoms of sacroiliac syndrome are usually experienced unilaterally and are well localised over the sacral sulcus or near the posterior superior iliac spine, unless both joints are affected when the pain is experienced bilaterally (Quon *et al.*, 1999). The pain referral from the sacroiliac joints may also be similar to that of a herniated lumbar intervertebral disc or lumbar facet syndrome, as it may radiate into the lower lumbar region, buttock, posterior thigh, groin, abdomen and rarely, pain radiating below the knee into the foot. However, the presence of groin pain may distinguish sacroiliac joint pain from other causes of low back or hip pain. Risk factors that can predispose an individual to sacroiliac syndrome include leg length discrepancy, gait abnormalities, scoliosis, spinal fusion and prolonged vigorous exercise (Cohen, 2005).

The muscles acting on the intervertebral joints may also be responsible for the patient's symptoms of low back pain as it is sometimes unclear whether the low back pain is due to the joint itself, or the muscles acting on the joint. A dysfunctional intervertebral joint may lead to local muscle contraction in order to protect the joint, or abnormal muscle function may lead to joint strain, but in most cases, the clinician is unable to determine which comes first (Kirkaldy-Willis and Bernard, 1999). Interestingly, the multifidus muscle is commonly involved in lumbar facet syndrome. Kirkaldy-Willis and Bernard (1999) postulate that muscle fatigue may be caused by local areas of vasoconstriction within the muscle and sustained muscle contraction that leads to an accumulation of metabolites within the muscle. This changes the sensitivity of the motor units and may lead to sudden, violent, uncontrolled contractions of especially the involuntary muscles, like the multifidus muscle. These uncontrolled contractions may lead to torsional injuries in the lumbar facet joints or the lumbar intervertebral discs. This injury may in turn lead to a reflex sustained contraction of the multifidus muscle. Travell and Simons (1999) extensively describe myofascial pain and dysfunction and how the referral of pain from trigger points may

cause pain, stiffness and restricted range of motion in the affected muscles and their joints. The severity of symptoms may range from agonising, incapacitating pain caused by very active trigger points to a painless restriction of motion or deformation of posture, such as scoliosis and hyper/hypolordosis, caused by latent trigger points. Myofascial trigger points have characteristic pain referral patterns that rarely coincide with dermatomal or peripheral nerve distributions, although they may cause autonomic phenomena. One such myofascial pain and dysfunction syndrome, piriformis syndrome, is commonly confused with a herniated intervertebral disc because pain and paraesthesias may be referred to the low back, groin, perineum, buttock, hip, posterior thigh, leg and foot. This syndrome has three components, viz. 1) myofascial pain referred from trigger points in the piriformis muscle, 2) nerve and vascular entrapment at the greater sciatic foramen by the piriformis muscle and 3) a dysfunctional sacroiliac joint. The dysfunction of the sacroiliac joint is an important component of the syndrome as it activates the trigger points in the muscles, which in turn perpetuates the dysfunction in the joint (Travell and Simons, 1999).

The relationship between lumbosacral transitional segments and low back pain is controversial because these congenital anomalies are frequently found in asymptomatic individuals. However, many structural problems that are found at the level above the anomaly may cause low back pain. These may include altered biomechanics, intervertebral disc bulges or herniations, annular tears in the intervertebral disc, central or lateral canal stenosis, facet arthritis and spondylolysis (Guebert *et al.*, 2005). Pillay (2007) observed that lumbosacral transitional segments were the most commonly occurring congenital anomalies and that patients who had a transitional segment were more likely to have a decreased lumbar range of motion, scoliosis and a loss of lumbar lordosis or hypolordosis.

The most common fracture of the lumbar spine is the compression fracture. This fracture is caused by a combination of flexion and axial compression and the extent of compression depends on the severity of the applied force and the strength of the vertebra. The incidence of compression fractures usually increases with age, and this is especially true in the case of osteoporotic patients. Females are affected more than males. Osteoporosis may lead to spontaneous compression fractures that occur during everyday activities without a major traumatic event (Yochum and Rowe, 2005).

Spondylolisthesis is a common condition with multiple aetiologies that may or may not result in low back pain. The most common type of spondylolisthesis is the isthmic type (Type II) and the pain generating structure is often unknown, but may be attributed to

lumbar facet syndrome, sacroiliac syndrome, intervertebral disc tear or herniation, muscle fatigue syndromes, periostitis and nerve root traction. Other forms of spondylolisthesis may be caused by pathologies of the bony anatomy or fractures. These forms may result in neurologic compromise from nerve root compression (Yochum and Rowe, 2005).

A precise cause of the patient's low back pain is more likely to be found in the non-mechanical disorders and in patients with radicular-type pain of non-mechanical origin (**Table 2.2**). Other terms for non-mechanical disorders may include pathological causes, systemic causes or specific causes. This category also encompasses referred pain of a non-mechanical origin. Specific, non-mechanical disorders are fairly rare and have a low prevalence in primary care. Most of the non-mechanical causes, whether spinal or visceral, will cause other signs and symptoms that will alert the clinician to their presence (Atlas and Deyo, 2001; Atlas and Nardin, 2003). The most common sources for metastatic cancer are the lung, breast and prostate and so these areas need to be examined when a malignancy is suspected. Spinal infections are usually spread haematogenously, therefore the patient should be examined for another source of infection (Jarvik and Deyo, 2002).

Other causes of low back pain may include those of an iatrogenic nature, idiopathic conditions and psychological conditions that may exacerbate the symptoms (**Table 2.2**). This category also encompasses the "yellow flags" which indicate psychosocial risk factors for the development of chronic pain and disability and they compliment the red flags (**Table 2.3**) as they may help predict those patients who may have poor recovery (Borkan *et al.*, 2002). There may be multiple aetiologies existing at any one time causing or exacerbating the symptoms of low back pain and the presence of psychological factors may increase the pain, chronicity or disability of low back pain patients. This has led researchers to sometimes refer to low back pain as a 'multifactorial biopsychosocial pain syndrome' (Borkan *et al.*, 2002). Kirkaldy-Willis and Bernard (1999) reported that the most common emotional disturbances that may exacerbate low back pain are tension, stress, anxiety, fear, uncertainty, resentment and depression.

The causes of low back pain are many and varied, but a thorough and detailed history and physical examination should uncover clinical findings which will direct a clinician to a particular diagnosis or differential diagnosis. In the case of a differential diagnosis, further investigations may be necessary to confirm or refute the clinical suspicion. These investigations may include plain film x-rays, CT scans and MRI scans.

2.2.1 FACTORS ASSOCIATED WITH THE DIAGNOSIS OF LOW BACK PAIN

Traditionally, much of the clinical encounter with the patient was spent searching for non-mechanical causes of low back pain, even though these disorders are fairly rare. It was also noted that most patients who had a history suggestive of a serious underlying pathology were actually found to have a non-specific, mechanical cause. The extent to which a clinician should search for a specific diagnosis is determined by the patient's history and physical examination findings. Therefore the goal of the examination should be to identify those patients at risk for a serious pathology and those patients who may be unresponsive to treatment as these situations may warrant further diagnostic testing. The history and physical examination can also help to determine the initial management and treatment of the patient (Atlas and Deyo, 2001; Atlas and Nardin, 2003). There is no universal gold standard for the diagnosis of low back pain and as such it is difficult to determine whether the clinical diagnosis is correct (Marriott *et al.*, 1999). The clinical diagnosis, based on history and physical findings, represents a working hypothesis or working diagnosis that needs to be proven or disproven (Tooke and Huckell, 1995). The working diagnosis allows clinicians to alter their impression of low back pain as it responds to treatment or further diagnostic evaluations reveal more likely underlying causes (Kent and Keating, 2004). As it is difficult to determine the exact pain generating structure in many cases of low back pain, many conditions are based on a diagnosis of exclusion. This is determined by excluding all of the possible serious pathologies until there is only a likely mechanical cause remaining (Pederson *et al.*, 1992).

A medical history and physical examination can identify possible causes of low back pain and certain clinical findings may be associated with a greater probability of developing a serious back condition, as shown in **Table 2.3**. These findings are termed "red flags" and may warrant a more detailed examination to determine the pathology responsible for the presenting symptoms (Atlas and Nardin, 2003; Peterson and Hsu, 2005). Red flags may indicate the presence of disorders like malignancy, infections, inflammatory arthritides, fractures (traumatic or osteoporotic), intervertebral disc herniations, or spinal stenosis (Jarvik and Deyo, 2002; Atlas and Nardin, 2003). The importance of identifying red flags cannot be overstressed because the underlying pathology may have dire consequences for the patient including destructive neurological or inflammatory processes that may leave the patient with permanent deficits (Haldeman, 1999). Red flags may manifest at any point

in the course of the patient's condition and so it is important to carefully monitor the patient for the development of red flags at a later stage in the treatment (Malanga and Chimes, 2008).

Table 2.3 Red flags associated with low back pain*

Disorder	History findings	Physical findings
General	Innocuous symptoms Nocturnal pain [2] Low back pain with or without radiation [3] Recurrent back pain with no x-rays in the past 2 yrs [4]	Innocuous manifestations[3] Abnormal gait [3] Motor or sensory deficit [4] Unexplained deformity [4]
Cancer	Age ≥ 65 yrs Suggestive history Constitutional symptoms Failure to improve with treatment[1]	Motor, sensory or reflex deficits Constitutional manifestations
Infection	Constitutional symptoms Suggestive history	Constitutional manifestations Innocuous manifestations
Inflammatory arthritis	Age <40 yrs Innocuous symptoms	Constitutional manifestations Pain and swelling of joints[5] Systemic manifestations[5]
Fracture	Age ≥50 yrs ≥70 yrs in cases of minor trauma Suggestive history	Local pain and swelling
IVD herniation [1]	Sciatica [1]	Motor and reflex deficits [1]
Spinal stenosis [1]	Age > 65 yrs [1] Innocuous symptoms [1] Sensory deficit[1]	Motor, sensory and reflex deficits[1] Abnormal gait[1]

*adapted from Atlas and Nardin (2003); [1] adapted from Jarvik and Deyo (2002); [2] adapted from Suarez-Almazor *et al.* (1997); [3] adapted from Scavone *et al*. (1981); [4] adapted from Simmons *et al.* (1995); [5]adapted from Yochum and Rowe (2005)

Yrs = years; IVD = intervertebral disc

Careful and thorough history taking may provide certain clues to the red flags associated with low back pain. Two of the most general red flags are duration of pain of greater than one month and no relief of pain obtained when in the supine position (Atlas and Nardin, 2003). Cauda equina syndrome constitutes a medical emergency and is in itself a red flag. Haldeman (1999) listed the specific red flags for cauda equina syndrome as saddle anaesthesia, a recent onset of bladder dysfunction that may include overflow incontinence, urinary retention and an increased frequency of micturition, and a progressive or severe neurological deficit in the lower limb. Red flags in the physical examination include unexpected laxity in the tone of the anal sphincter, perineal or perianal sensory loss and major motor weakness in the lower limb which may be characterised by weakness of knee extension and a foot drop (Haldeman, 1999). Other

red flags which a patient may present with include persisting sensory or motor deficits, unexplained structural deformity, worsening of pain or other symptoms despite adequate treatment, intense pain at rest, recurrent low back pain for a period of greater than two years with no x-ray evaluation, previous spinal surgery or fracture and when the patient is unable to give a reliable history (Simmons *et al.*, 1995).

A previous history of cancer will always be a red flag in any patient. As the patient's age increases, so does their risk for cancer. Clinicians should be particularly cognizant of this in patients older than 50 years of age (Atlas and Nardin, 2003). As well as patients older than 50 years of age, Suarez-Almazor *et al.* (1997) and Moffett and McLean (2006) include patients under the age of 20 years as red flags for cancer and infections. Unexplained weight loss and lymphadenopathy are constitutional symptoms that are often found in the cancer patient and so they will be red flags when found upon examination. Neurological abnormalities always constitute red flags, although they are more often attributed to intervertebral disc herniations or spinal stenosis rather than malignancy (Atlas and Nardin, 2003). Haldeman (1999) also includes severe nocturnal pain as a red flag for both malignancies and infection and Moffett and McLean (2006) also include progressive, constant non-mechanical pain that is not relieved by bed rest.

Constitutional symptoms that are often seen in cases of infection and may include fever or chills, recurrent skin or urinary infections and immunosuppression associated with injection drug abuse. A fever of greater than 38°C should alert the clinician to the likelihood of an infective cause of the pain. Tenderness over the spinous processes is listed as a red flag for infection (Atlas and Nardin, 2003). HIV-positive status is included as a red flag for potentially serious pathology (Moffett and McLean, 2006).

A gradual onset of pain, morning stiffness and improvement of pain with exercise especially in males over the age of 40 years are reported by Atlas and Nardin (2003) to be red flags for inflammatory arthritis. Yochum and Rowe (2005), on the other hand, reported that the peak age of onset to be between 20 and 40 years and there is a greater female predilection for inflammatory arthropathies.

Significant trauma like a fall from a height, or a motor vehicle accident will substantially increase the likelihood of a fracture, even in younger patients. In older patients, usually those over 50 years of age, but more specifically in those over 70 years of age, fractures may occur in the case of minor trauma. This is especially true in the case of osteoporotic patients (Atlas and Nardin, 2003). Strenuous lifting may also induce fractures in the osteoporotic patient (Suarez-Almazor *et al.*, 1997). A history of prolonged corticosteroid

use or substance abuse should also raise the suspicion of fractures as they may decrease the bone density. Substance abuse may also lead to higher rates of trauma which would put the patient at a higher risk of fracture (Atlas and Nardin, 2003). A red flag for a stress fracture may include a history of repetitive stress of adequate severity (Simmons *et al.*, 1995).

2.2.2 THE RELATIONSHIP BETWEEN THE HISTORY AND EXAMINATION FINDINGS AND THE DIAGNOSIS OF LOW BACK PAIN

Many authors have tried to link specific history and physical examination findings with certain disorders (Scavone *et al.*, 1981; Suarez-Almazor *et al.*, 1997; Jarvik and Deyo, 2002; Atlas and Nardin, 2003) and reported that there is no relationship between transitional vertebrae or spondylosis and low back pain, whereas degenerative intervertebral disc disease, spondylolysis and spondylolisthesis are thought to cause low back pain. Other authors have shown that there is a weak association between the presenting symptoms, examination findings and the anatomic changes in low back pain (Atlas and Deyo, 2001). Jensen *et al.* (1994) state that the relationship between low back pain and lumbar spine abnormalities is controversial because a substantial number of people may have abnormalities, like lumbar intervertebral disc bulges or facet arthropathy, but have no back pain. Lutz *et al.* (2003) reported that many patients may have the characteristic signs and symptoms of a disease but do not actually have the causative lesion. A definitive diagnosis cannot be made in as many as 85% of patients because there is no close association between the presenting symptoms and the pathologic changes seen (Jarvik and Deyo, 2002) emphasising the difficulty of diagnosing low back pain (Pederson *et al.*, 1992; van Tulder *et al.*, 1997).

This controversy is highlighted by the conflicting information reported by many authors and the lack of proper definition of the terms spondylosis and degeneration. Scavone *et al.* (1981) and van Tulder *et al.* (1997) report that there was no relationship between non-specific low back pain and partial or complete transitional vertebrae. Pillay (2007), on the other hand, observed that complete lumbarisation was associated with a decreased lumbar lordosis. This change in the lumbar curvature may lead to disturbances in the biomechanics of the lumbar spine giving rise to low back pain of mechanical origin. van Tulder *et al.* (1997) reported that there did not seem to be a relationship between non-

specific low back pain and spondylosis, spondylolysis, spondylolisthesis, spina bifida occulta and Scheuermann's disease, but they did report that there seemed to be a relationship between degeneration and non-specific low back pain. Scavone *et al.* (1981) reported that there was no relationship between low back pain and spondylosis, but found degenerative disc disease to be associated with low back pain and that spondylolysis and spondylolisthesis was found more in symptomatic patients.

2.3 THE ROLE OF PLAIN FILM X-RAYS IN DIAGNOSING LOW BACK PAIN

2.3.1 UTILISATION OF X-RAYS IN CLINICAL PRACTICE

Plain film radiographs or x-rays are often utilised as a screening tool to identify the more serious causes of low back pain (**Table 2.3**). These conditions may require specific treatment strategies or substantially affect the patient's prognosis (van Tulder *et al.*, 1997). Skeletal radiography is one of the most common imaging tests because it is readily available, has a low cost and the results are relatively easy to interpret (Jarvik and Deyo, 2002; Yochum and Rowe, 2005). Chiropractors have been utilising x-rays to assist in the diagnosis of their patients almost since the discovery of ionizing radiation in 1895 (Peterson and Hsu, 2005). Sherman (1986) and Phillips (1992) compiled lists of reasons why investigative radiology forms an integral part of chiropractic practice. These include:

- X-rays are an adjunct to the clinical diagnosis
- Identification of anatomical or biomechanical anomalies
- Exclusion of serious pathology
- Screening for contraindications to spinal manipulation
- Monitoring disease progression
- Medicolegal protection

The general indications for skeletal radiology are shown in **Table 2.4**, but these are also applicable to cases of low back pain. Many of the probable indicators are red flags (**Table 2.3**) for serious pathologies, according to the medical authors Simmons *et al.* (1995) and

Atlas and Nardin (2003). The possible indicators for radiology also contain factors relating to the technical quality of the x-ray films.

Table 2.4 Indications for skeletal radiology*

Probable indicators	Possible indicators	Non-indicators
Trauma (recent or old)	> 50 yrs of age	Patient education
Unexplained weight loss	Drug or alcohol abuse	Routine screening
Nocturnal pain	Corticosteroid use	Habit
Neuromotor deficit	Unavailability of alternate imaging	Discharge status assessment
Inflammatory arthritis	Unavailable, lost or technically inadequate previous studies	Routine biomechanical assessment
History of malignancy	Dated previous studies	Pre-employment status
Fever of unknown origin (>37.7ºC)	Research	Physical limitations of patient
Abnormal blood finding	Constitutional or systemic disease	Inadequate equipment
Deformity (scoliosis)	Recent immigration	Non-trained personnel
Failure to respond to therapy	Therapeutic risk assessment (contraindications)	Financial gain
Medicolegal implications	Response to treatment	Recent high-level radiation exposure
		Pregnancy

*adapted from Yochum and Rowe (2005)

yrs = years; > = greater than

Evidence-based guidelines for the use of radiography suggest that x-rays should only be requested in more serious cases as indicated by the presence of red flags (Simmons *et al.*, 1995; Atlas and Nardin, 2003). Plain film x-rays do not provide any useful information in the acute phase of low back pain, except in the presence of red flags (Patel and Ogle, 2000). As a result they are generally not recommended in the first month of symptoms (Malanga and Chimes, 2008). If the patient is not responding to adequate conservative treatment within four to six weeks of the commencement of such treatment, the clinician should reassess the patient and request lumbar spine x-rays (Patel and Ogle, 2000). Furthermore, if the patient is experiencing intractable pain or worsening neurological symptoms in this time period, they should be referred for lumbar spine x-rays immediately.

X-rays may identify many abnormalities that are unrelated to the patient's low back pain symptoms and this is shown by the fact that many of these abnormalities are equally prevalent in people with and without low back pain (Jarvik and Deyo, 2002). These abnormalities are called incidental findings as they were not expected to be observed. The dilemma with an incidental finding is to decide whether it represents a variation of the normal anatomy that may not be clinically relevant, a clinically significant finding, or a potentially important diagnostic finding that leads to a different diagnosis with new diagnostic tests and treatments (Royal *et al.*, 1993; Lumbreras *et al.*, 2010). Lumbreras *et al.* (2010) reported that the highest prevalence of incidental findings was found in older

patients with major co-morbidities. This finding was attributed to the fact that the body changes with age and so the age-related changes of degeneration, atrophy and atherosclerosis are more prominent in the older age groups than the younger age groups.

Beck *et al.* (2004) reported that the most common incidental findings included degenerative joint disease (23.8%), lumbosacral transitional segments (9.8%), mild scoliosis of less than 20° (1.3%), spondylolisthesis (7.8%), congenital block vertebra (1.4%) and soft tissue abnormalities (13.5%) such as calcification and abdominal aortic aneurysms. In a study to determine the frequency of incidental findings, Lumbreras *et al.* (2010) found that diagnostic imaging may reveal unexpected or incidental findings in 15% of all studies performed. Of this 15%, 16.2% were related to musculoskeletal lesions, with the most common lesions being vertebral body deformation, degenerative changes, haemangioma, healed fractures, osteitis condensans illi and spondylosis. Unfortunately the authors did not define their use of the terms spondylosis and degeneration.

Initially, it is necessary to only obtain two radiographic views of the lumbar spine, the antero-posterior (AP) and lateral views (Patel and Ogle, 2000; Atlas and Nardin, 2003). This follows the basic principle that it is necessary to have a minimum of two views that are perpendicular to each other in order to evaluate a set of plain film radiographs (Yochum and Rowe, 2005). The AP and lateral views of the lumbar spine are able to demonstrate the alignment of the lumbosacral spine, the intervertebral disc and vertebral body heights, the bony anatomy of the lumbosacral spine and they allow for a gross estimation of bone density (Jarvik and Deyo, 2002). Any additional views like oblique views or flexion-extension stress studies should only be requested when specifically relevant to the patient (Atlas and Nardin, 2003). However, it has been suggested that no new information may be seen in these extra views that isn't already visible on the AP and lateral views (Simmons *et al.*, 1995).

2.3.2 ADVANTAGES OF X-RAYS IN DIAGNOSING LOW BACK PAIN

One of the key advantages of plain film radiography is its ability to demonstrate bony landmarks and to assess adjacent structures over a considerable distance. It is relatively non-invasive, readily available and comparatively inexpensive and as such is often used as an initial investigation in skeletal abnormalities (Yochum and Rowe, 2005). It depicts anatomic details in such a way that it is easy to understand the three-dimensional relationships of structures and may provide important information that requires further

specialist imaging. Radiography is important to track changes in a disease process over time and may identify congenital abnormalities, and incidental bone or soft tissue abnormalities. It is possible to pinpoint a definitive diagnosis or at least form a list of differential diagnoses from the radiographic findings (Yochum and Rowe, 2005).

2.3.3 LIMITATIONS OF X-RAYS IN DIAGNOSING LOW BACK PAIN

Plain film radiography does have some limitations. Even though it is essentially a non-invasive procedure, the patient is still exposed to ionizing radiation for a 1 in 2500 chance of identifying a significant pathology (Phillips, 1992). Soft tissue structures are not visualised very well at all. Technical artefacts and the effect of exposure differences and patient positioning may lead to difficulties in interpreting the x-rays. A 30-50% loss of bone density is necessary for it to be visible on an x-ray and a lesion must be at least 1-5cm in size before it will be visible. A radiographic latent period means there may be a time delay between the onset of clinical symptoms and the visibility of the radiographic findings. Aggressive tumours may take as long as four to six weeks to manifest radiographically, whereas osteomyelitis takes 10-14 days to manifest in the peripheral bones and 21 days to manifest in the spine. For these reasons, the patient may have a normal appearing x-ray but actually has a histologic disease (Yochum and Rowe, 2005). Plain radiographs may miss early tumours and infections and cannot diagnose intervertebral disc herniations or non-osseous causes of spinal stenosis (Atlas and Nardin, 2003).

2.4 THE RELATIONSHIP BETWEEN THE CLINICAL AND RADIOGRAPHIC FINDINGS OF LOW BACK PAIN

Even though lumbar spine x-rays are often requested in cases of low back pain, they have a low diagnostic yield (Selim *et al.*, 2000). Radiographic findings are poorly associated with clinical symptoms and as such they are deemed to be non-specific (Atlas and Nardin, 2003). Some important causes of low back pain cannot be identified with plain film radiographs and so x-rays are not sensitive to these causes. Furthermore, findings from plain radiographs are poorly associated with low back pain symptoms (Atlas and Deyo, 2001).

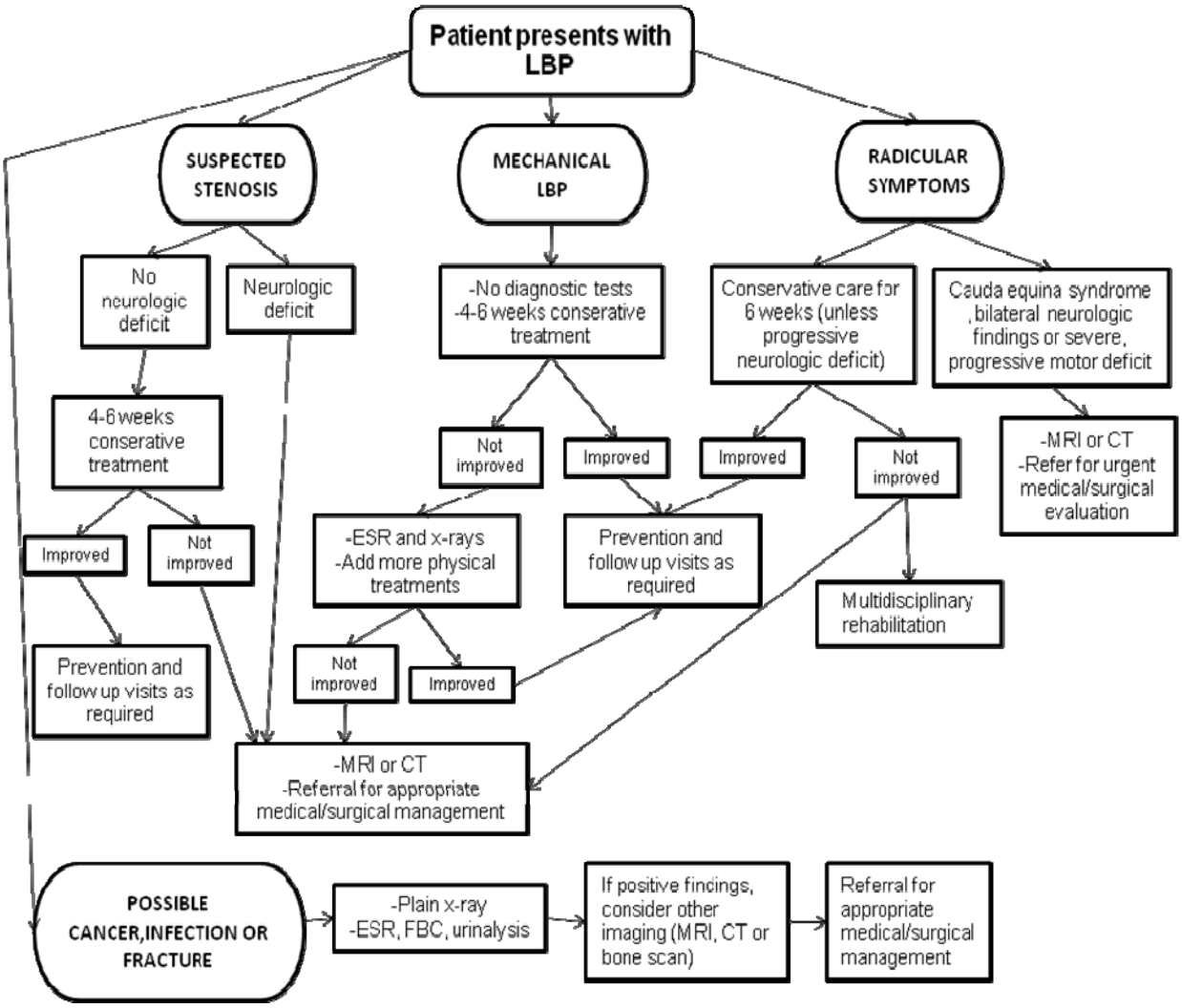
Abnormal radiographic findings are found in a large proportion of the asymptomatic population and this casts doubt that the abnormal structure is responsible for the patient's symptoms (Kent and Keating, 2004). A number of abnormalities are found in essentially normal individuals, especially as they get older, and these may include lumbar intervertebral disc degeneration, spondylosis, facet joint arthritis, spondylolysis, mild to moderate scoliosis, intervertebral disc calcification, Schmorl's nodes and some congenital anomalies (Jarvik and Deyo, 2002; Atlas and Nardin, 2003). It was reported by van Tulder *et al.* (1997) that radiographic findings of degeneration, congenital abnormalities and postural abnormalities are not related to non-specific low back pain and that the reliability of these findings is low. However, after their review of the literature, they reported that degeneration is associated with low back pain but other radiographic findings were not related. It is the opinion of these authors that this result may have been due to confounding bias and so they concluded that no firm evidence could be found to prove or disprove a causal relationship between non-specific low back pain and any specific radiographic findings.

X-rays may be unable to denote the exact structure causing the pain and may often miss certain spinal pathologies, especially those of soft tissue origin (Sembrano and Polly, 2008). Although Atlas and Nardin (2003) reported that radiographic findings poorly correlated with the symptoms of low back pain, sensory and motor deficits were observed to have a good correlation with radiographic findings (Scavone *et al.,* 1981). Research conducted at a university teaching hospital by Scavone *et al.* (1981) evaluated the use of lumbar spine films by the oncology referral centre. They correlated patient's history and physical examination findings (both inpatients and outpatients) with four groups of radiological findings: (1) radiologically normal, (2) incidental findings unrelated to patient's complaints, (3) diagnostic films compatible with symptoms, and (4) radiological findings of questionable clinical significance. Their research showed that at their institution, lumbar spine films yielded insignificant or non-diagnostic information in more than 50% of the cases, and they believed that this high percentage of unproductive studies indicated an overuse of x-rays at their hospital (Scavone *et al.*, 1981).

2.5 AN OVERVIEW OF THE MANAGEMENT OF LOW BACK PAIN

The management of low back pain varies for different clinical diagnoses and depending on the profession of the health care worker. For example, a medical doctor will rely more

on pharmacological interventions, whereas a surgeon will tend to opt for surgical interventions, or a chiropractor will mainly utilise spinal manipulative therapy. A general algorithm for the management of low back pain adapted from Jarvik and Deyo (2002), Atlas and Nardin (2003) and Souza (2009) is depicted in **Figure 2.1**. This suggested algorithm divides the treatment paths according to the suspected aetiology.



Key: LBP= low back pain; ESR= erythrocyte sedimentation rate; FBC= full blood count; MRI= magnetic resonance imaging; CT= computed tomography

Figure 2.1 Suggested algorithm for the management of low back pain*

*Adapted from Jarvik and Deyo (2002), Atlas and Nardin (2003) and Souza (2009).

In most cases, the first line of management for the low back pain patient is to identify the potentially serious causes of low back pain and to refer the patient for the appropriate treatment. This may include the use of diagnostic tests or imaging such as plain film x-rays, MRI, CT, erythrocyte sedimentation rate (ESR), full blood count (FBC) and urinalysis **(Figure 2.1)**. Depending on the results of these tests, the patient will then be referred for appropriate conservative, medical or surgical treatment.

Following this initial triage of low back pain patients, most patients will undergo a period of four to six weeks of conservative treatment. This conservative treatment usually includes education, activity modification, gradual return to activity, specific exercises, low stress aerobic exercise, heat or cold therapy, massage and the use of appropriate medications if necessary (Jarvik and Deyo, 2002; Atlas and Nardin, 2003). Furthermore, if it is deemed appropriate, manual therapy including spinal manipulation and mobilisation may be commenced. This is most often provided by complementary and alternative medicine (CAM) providers, such as chiropractors. It has been observed that patient satisfaction is higher when treatment is provided by CAM clinicians as opposed to physician-directed care (Atlas and Nardin, 2003). Behavioural therapy may be important in cases of chronic low back pain to modify the patient's response to their pain and therefore reduce any subsequent disability (Atlas and Nardin, 2003).

Education is an important component of any management plan. Atlas and Nardin (2003) state that the focus should be on educating the patient about the cause of their low back pain, the natural history of the condition, the role of diagnostic testing and imaging as it applies to the patient's condition, treatment recommendations including activity modification and preventative measures, when to consult a clinician and whether surgery is appropriate.

Heat and cold therapy as well as massage or other soft tissue therapies are commonly used to treat low back pain. Bed rest should be limited and activity modification should include avoiding activities that aggravate the patient's pain. Patients are instructed to avoid prolonged periods of sitting or standing and should avoid strenuous activity. Low stress aerobic exercise, especially in the form of walking, may be included as well as low back stretching and strengthening exercises. The patient is advised to gradually return to their previous activities after their symptoms have been consistently improving over a few treatments (Atlas and Nardin, 2003). Non-steroidal anti-inflammatory drugs (NSAID) or paracetamol are the drugs of choice when patients have acute low back pain although opiates or muscle relaxant drugs may be used in the case of severe pain. Short-acting or

long-acting opioids are often prescribed in chronic low back pain although they have a limited efficacy (Atlas and Nardin, 2003).

At the end of this four to six week trial of conservative therapy, the patient will be re-assessed to determine whether their condition has improved with treatment. If it has not improved, many patients are sent for spinal imaging, namely x-ray evaluation (Jarvik and Deyo, 2002; Atlas and Nardin, 2003). The findings from the x-rays will aid the clinician in deciding whether to continue treatment or if the patient needs more advanced diagnostic tests and imaging. If cauda equina syndrome is suspected this should be classed as a medical emergency and the patient should immediately be referred for urgent medical or surgical evaluation, at which point the clinician may request MRI or CT evaluation (Atlas and Nardin, 2003).

Surgery is almost always elective in the case of sciatica due to a herniated intervertebral disc or spinal stenosis (Atlas and Deyo, 2001). Patients with chronic low back pain without radicular-type pain tend to have continual pain and disability after surgery so conservative treatment is recommended for these patients (Atlas and Nardin, 2003). A patient should be considered for surgery if they meet all four of the following criteria or if they have severe, progressive neurologic deficit (Atlas and Deyo, 2001):

1. Leg pain that is equal to or worse than the patient's back pain
2. A positive straight leg raise test
3. No response to a trial of conservative therapy (four to six weeks for patients with a herniated intervertebral disc and eight to 12 weeks for a patient with spinal stenosis)
4. Imaging findings that reveal a lesion corresponding to the patient's symptoms.

Common surgical procedures include discectomy for herniated intervertebral discs, and fusion or non-fusion spinal procedures or laminectomies for spinal stenosis (Atlas and Nardin, 2003).

2.5.1 CHIROPRACTIC MANAGEMENT OF LOW BACK PAIN

The patient should be screened for indications and contraindications to spinal manipulative therapy, therefore the first steps in the chiropractic management of low back pain would be to evaluate the patient for any evidence of tumour, infection or fracture and

if any are present, the patient should be sent for medical evaluation and management (Souza, 2009). If the pain is of a mechanical origin, the patient should be managed conservatively for a period of at least one month. If the patient does not respond positively to the treatment, they should be referred for further testing and a second opinion is also suggested (Souza, 2009).

The indications for manipulative therapy include facet joint dysfunction (lumbar facet syndrome), myofascial pain and dysfunction syndromes, facet joint dysfunction coexisting with central or lateral canal stenosis or with spondylolisthesis, herniated nucleus pulposus and sacroiliac joint syndrome with normal x-rays (Kirkaldy-Willis and Bernard, 1999). The relative contraindications to manipulative therapy are those conditions that may require modification of the manipulative technique and are specific to each patient's case. The relative contraindications to manipulation reported by Kirkaldy-Willis and Bernard (1999) include acute intervertebral disc herniation, osteopaenia, inflammatory arthritides of the spine, patients being treated with anticoagulant medications, bleeding disorders and psychological problems. The absolute contraindications to manipulation include progressive neurological deficits, destructive lesions of the spine, pelvis or ribs, healing fractures or dislocations, avascular necrosis of any bones within the axial skeleton, cauda equina syndrome, large abdominal aortic aneurysms, visceral referred pain and malingering.

The treatment options that may be available to the chiropractor may include education, manipulation or other manual therapies, physical therapy modalities such as soft tissue therapies, traction, heat, electrical modalities such as ultrasound and the use of back supports (Kirkaldy-Willis and Bernard, 1999). Acupuncture, spinal stabilisation exercises, massage and advice on lifestyle modification are other tools that a chiropractor may employ (Souza, 2009).

At the CDC at DUT, there are various treatment modalities available to the students to utilise during the treatment of their patients (Chiropractic Clinic Manual, 2010). The primary modality utilised is manual therapy which may include lumbar spine or sacroiliac joint manipulation, mobilisation techniques and the use of pelvic blocking. This primary modality may be supplemented by the use of electrotherapy, soft tissue techniques, stretching or strengthening exercises and some other techniques. The forms of electrotherapy available to the students include interferential current therapy (IFC), transcutaneous electrical nerve stimulation (TENS), ultrasound or action potential stimulation (APS). Massage, ischaemic compression of myofascial trigger points, grip and

rip and dry needling are some of the soft tissue techniques employed and stretching or strengthening may include proprioceptive neuromuscular facilitation stretches (PNF), static stretches or strengthening exercises. A few of the other modalities available include the application of heat, ice or traction.

Patient well-being is always the foremost concern at the DUT CDC, hence all patient information is kept confidential and patients are always kept well informed about their treatment and management procedures whilst treatment is being undertaken at the CDC (Chiropractic Clinic Manual, 2010). The CDC aims to provide quality chiropractic care and patient education consistent with current evidence-based health care. This is supplemented by co-operation with other health care institutions and practitioners to create a pool of knowledge and an exchange of ideas and information from which the CDC's students may acquire further clinical experience and knowledge (Chiropractic Clinic Manual, 2010).

The CDC's Radiographic Guidelines and Procedures indicate that x-rays are only to be obtained when they will significantly contribute to the patients' diagnosis and management plan and that they should primarily be used for the purposes of confirming or rejecting a clinical impression established by obtaining a thorough history and physical examination. X-rays should not be used for general screening purposes in order to help minimize the amount of ionizing radiation to which the patient is exposed (Chiropractic Clinic Manual, 2010).

2.6 CONCLUSION

Low back pain is a common condition and affects most people at least once in their lives. The causes of low back pain are numerous and may include non-specific mechanical causes, or specific causes which may have a more serious nature. Researchers have tried to link specific history and physical examination findings with certain disorders with little success. Red flags in the history or physical examination may indicate the presence of the more serious aetiologies which may warrant further investigation. X-rays may be used as a screening tool to indicate the presence of a more serious aetiology and chiropractors have been utilising them for many years to aid in the diagnosis of low back pain. Evidence-based guidelines recommend that x-rays only be taken in the presence of red flags or if there is no improvement after four to six weeks of conservative treatment. However, research has shown that x-rays are being over utilized and the guidelines are

not always adhered to. There is also a paucity of literature on the role of x-rays in influencing the management of patients with low back pain. Therefore the aim of this study was to determine whether there is a relationship between the clinical and radiographic diagnoses of patients who present with low back pain at a chiropractic teaching clinic, and whether lumbar spine x-rays influence a change in the diagnosis or management of these patients.

CHAPTER THREE

MATERIALS AND METHODS

3.1 STUDY DESIGN

This research was designed as a quantitative, non-experimental, retrospective empirical clinical cohort study. Data were collected from the lumbar spine x-rays and corresponding patient files of patients who presented with low back pain at the CDC at the DUT from 1 January 1997 to 31 July 2010. Approval to conduct this study and ethical clearance was obtained from the Faculty of Health Sciences Research Committee at DUT. **(Ethics clearance certificate number: 028/10 [Appendix C])**

3.2 PATIENT CONFIDENTIALITY

All patients who presented to the CDC were required to sign an informed consent form before being examined or treated. The informed consent also included written consent to their clinical and radiographic records being utilised for research purposes with the proviso that their identities would not be revealed in any way whatsoever. Throughout the research process, the confidentiality of the patients' information was maintained. All patients' names were coded and did not appear on any data sheets or in this dissertation. Only the researcher and the supervisor had access to the files and x-rays.

3.3 SAMPLING METHOD AND SAMPLE SIZE

Purposive sampling was used and all information collected was recorded on data sheets (**Appendix A**). The sample consisted of patients who presented to the CDC for low back pain and had lumbar spine x-rays taken at some point during their management at the CDC from 1 January 1997 to 31 July 2010. As at the end of July 2010, a total of 185 lumbar spine x-rays were found in the CDC archives. From this number, all patient files

and x-rays which did not satisfy the inclusion and exclusion criteria for this study were excluded. The final sample size was therefore 74 patient files with corresponding lumbar spine x-rays.

3.4 INCLUSION AND EXCLUSION CRITERIA

3.4.1 Inclusion Criteria:

1. Files with clinical records of patients' who must have presented to the CDC for treatment for low back pain.
2. Radiographs of the lumbar spine must have been taken at some stage during the selected patient's treatment or consultation at the CDC.
3. A minimum of an antero-posterior (AP) and lateral lumbar spine views were required for each selected patient.

3.4.2 Exclusion Criteria:

1. Radiographs which were taken prior to the patient's first consultation at the CDC.
2. Patient files that did not have a patient history, physical examination, low back orthopaedic examination and a SOAPE (Subjective, Objective, Assessment, Plan and Education) note corresponding to the date of the x-ray request form.
3. Any x-rays which had not been reported by a radiologist or if the radiology report was missing.

3.5 RESEARCH PROCEDURE

This study took place in three phases:

3.5.1 Phase One:

X-rays from the archives of the CDC were sorted and all lumbar spine x-rays were placed aside. The patients' names and date of birth were recorded on the patient confidentiality coding sheet (**Appendix B**). This was done to locate the corresponding patient files using the CDC computer archive system. A code was assigned to each patient's name. This coding system was utilised in all subsequent data sheets (**Appendix A**). The patient confidentiality coding sheet (**Appendix B**) and all data sheets (**Appendix A**) were kept in

a file at the CDC during the research process. This file was kept in a lockable cupboard at the CDC after the research was completed and will be shredded after five years.

3.5.2 Phase Two:

All x-rays and patient files were briefly evaluated to determine whether they satisfied the inclusion criteria. Those that did not satisfy these criteria were excluded from the study.

3.5.3 Phase Three:

This was the data collection phase. All collected data were recorded on the data sheets (**Appendix A**). To avoid bias the AP and lateral views of the lumbar radiographs were reviewed first, without previous knowledge of the patients' main complaint. The ABCS (Alignment, Bone, Cartilage, Soft tissue) system was used to evaluate the x-rays and all findings **(Table 3.1)** were recorded on the data sheet (**Appendix A**). The radiographic findings were checked against the radiologist's report and by the research supervisor. The patients' file was then evaluated and the following data was recorded as shown in **Table 3.1**:

Table 3.1 Data collection and source

Data that was collected	Source
Code and basic demographic information: code, age and gender	Patient confidentiality coding sheet (**Appendix B**) Case history form
Date of the initial consultation	Case history form and SOAPE note
Main complaint (low back pain with/without radiation)	Case history form
Outline of treatment before x-rays*	SOAPE note
Reason for x-ray referral/ suspected clinical diagnosis	SOAPE note and/or radiology request form
Date of x-rays	Radiology report and/or identification marker on x-ray films
Radiographic diagnosis	Radiology report
Radiographic incidental findings	Radiology report and/or findings of the researcher (and confirmed by supervisor/radiologist)
Clinical diagnosis after x-rays	SOAPE note
Change (or no change) in treatment after x-rays	SOAPE note

* X-rays refer to the lumbar spine x-rays

3.6 STATISTICAL ANALYSIS:

The association between the radiographic diagnosis and the clinical diagnosis was to be determined using McNemar's chi square tests for binary paired proportions. A *p* value of ≤0.05 was considered as statistically significant. Diagnoses were categorised into specific groups and indicator variables were used to construct two-by-two tables of absence or presence of radiographic versus clinical diagnosis for each specific diagnosis. Therefore, the association between radiographic and clinical diagnoses could be assessed for each condition separately (Esterhuizen, 2010). However there were too many categories for this to be done. The attempts at correlating the primary clinical diagnosis with the primary and secondary radiographic diagnoses were unsuccessful as the clinical diagnosis and radiographic diagnosis were not the same. Therefore, a paired test was not carried out. SPSS version 15.0 (SPSS Inc, Chicago, Illinois, USA) was used to analyse the data. It was not possible to assess any statistical association between the clinical diagnosis and radiological diagnosis in a paired comparison, as the categories were different. Similarly there were too many categories of each to allow statistical comparison using a chi square test. Therefore, a descriptive assessment of the radiological diagnoses for each clinical diagnosis was performed by cross tabulating the primary clinical diagnosis with the primary radiological diagnosis and the secondary radiological diagnosis respectively (Esterhuizen, 2011). The other objectives were purely descriptive and the outcomes were reported using frequency counts and percentages since all outcomes were categorical variables (Esterhuizen, 2010).

CHAPTER FOUR

RESULTS

4.1 AGE AND GENDER

Seventy four patient files and their corresponding lumbar spine x-rays were inspected in this study. The mean (± SD) age of the patients whose clinical files and lumbar spine x-ray records were examined was 43.9 (± 16.9) years while the range was from 10 - 79 years. The data of 40 male and 34 female subjects were obtained in this study as shown in **Figure 4.1**.

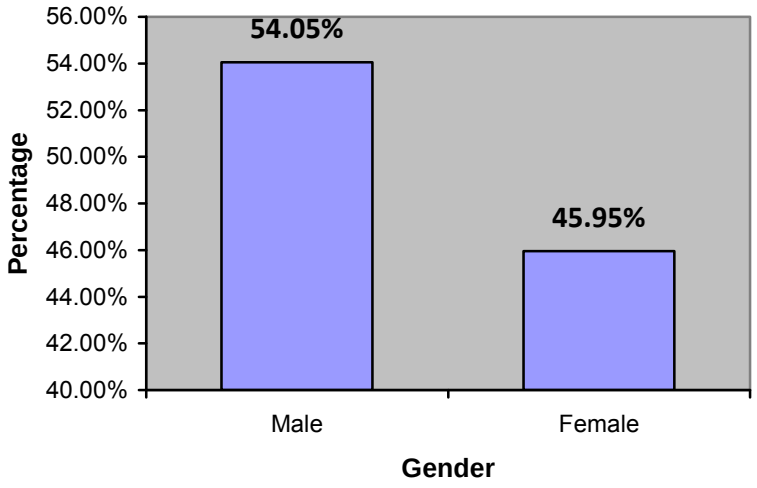


Figure 4.1 Gender distribution of patients whose radiographic and clinical records were inspected

4.2 THE RELATIONSHIP BETWEEN THE CLINICAL AND THE RADIOGRAPHIC DIAGNOSES OF PATIENTS WITH LOW BACK PAIN

The attempts at correlating the primary clinical diagnosis with the primary and secondary radiographic diagnoses were unsuccessful as the clinical diagnosis and radiographic diagnosis were not the same. Therefore, a paired test was not carried out. A cross tabulation was carried out between the primary clinical diagnosis and the primary radiological diagnosis (**Table 4.1**) and between the primary clinical diagnosis and the secondary radiological diagnosis (**Table 4.2**) but there were too many categories. This meant that too many cells had zero values and prevented a chi squared statistical test or any other statistical test to correlate the variables from being performed (Esterhuizen, 2011). Instead the relationship between the primary clinical diagnosis and either the primary or secondary radiographic diagnosis is shown in **Tables 4.1** and **4.2**.

The primary radiographic diagnosis relates to essentially what the patient was diagnosed with based on the radiographic findings. The secondary radiographic findings refer to findings that were also identified on the patient's x-rays but they were not the main diagnosis. They were also recorded as they may have had a causative relationship to the presenting complaint. In **Table 4.1** 'no diagnosis' refers to those patients who were not clinically diagnosed when x-rays were requested and so the clinical diagnosis was, therefore, pending the findings of the x-ray results.

Of all the primary radiographic diagnoses, spondylosis was most commonly observed in patients who were clinically diagnosed with either lumbar facet syndrome or sacroiliac syndrome (**Table 4.1**). No significant radiographic features were observed in patients who were clinically suspected of TB of the spine or cancer. Loss of the lumbar lordosis and osteoporosis were the two predominant secondary radiographic diagnoses (**Table 4.2**). Disturbances of the lumbar curvature, especially loss of lordosis were most commonly observed in patients with mechanical low back pain especially lumbar facet and sacroiliac syndromes (**Table 4.3**). Only one patient who presented with low back pain had a congenital anomaly in the lumbar spine and this was an ununinted ring apophysis. Scoliosis was observed in 14.8% (n = 22) of patients who presented with low back pain while spondylitic changes in the lumbar spine accounted for 31.1% (n = 46) of the observed radiographic findings. Twenty three percent (n = 17) of radiographic reports had no secondary radiographic diagnoses (**Table 4.2**).

Table 4.1 Primary clinical diagnosis versus primary radiographic diagnosis

Primary Clinical Diagnosis	Primary Radiographic Diagnosis								
	Compression Fracture	Loss of lordosis	Normal	Old trauma	Osteoporosis	Scoliosis	Spondylolisthesis	Spondylosis	**Total**
Suspected cancer	0	0	0	0	0	0	0	2	**2**
Claudication	0	0	0	0	0	0	0	1	**1**
Coccydynia	0	0	0	0	0	0	0	1	**1**
Instability of the lumbar spine	0	0	0	0	0	1	0	0	**1**
IVD herniation	0	0	0	1	0	2	0	3	**6**
Lumbar facet syndrome	0	1	1	3	0	7	0	13	**25**
Lumbar paraspinal myofasciitis	0	0	0	0	0	1	0	3	**4**
No diagnosis	0	1	0	0	0	0	0	1	**2**
SI syndrome	1	3	0	1	1	1	1	19	**27**
Spondylolisthesis	0	0	0	1	0	0	0	0	**1**
Spondylosis	0	0	0	0	0	0	0	3	**3**
TB of the spine	0	0	0	0	0	1	0	0	**1**
Total	**1**	**5**	**1**	**6**	**1**	**13**	**1**	**46**	**74**

IVD = intervertebral disc; SI = sacroiliac; TB = Tuberculosis

Table 4.2 Primary clinical diagnosis versus secondary radiographic diagnosis

Primary Clinical Diagnosis	Secondary Radiographic Diagnosis									
	Congenital	Increased lordosis	Loss of lordosis	No diagnosis	Old trauma	Osteoporosis	Scoliosis	Spinal stenosis	Spondylolisthesis	**Total**
Suspected cancer	0	0	0	1	0	1	0	0	0	**2**
Claudication	0	0	0	0	1	0	0	0	0	**1**
Coccydynia	0	0	1	0	0	0	0	0	0	**1**
Instability of the lumbar spine	0	0	1	0	0	0	0	0	0	**1**
IVD herniation	0	0	3	2	0	0	1	0	0	**6**
Lumbar facet syndrome	1	3	5	8	1	6	1	0	0	**25**
Lumbar paraspinal myofasciitis	0	0	0	1	1	0	2	0	0	**4**
No diagnosis	0	0	0	1	0	1	0	0	0	**2**
SI syndrome	0	1	7	4	3	4	4	1	1	**25**
Spondylolisthesis	0	0	1	0	0	0	0	0	0	**1**
Spondylosis	0	0	0	0	0	2	1	0	0	**3**
TB of the spine	0	0	1	0	0	0	0	0	0	**1**
Total	**1**	**4**	**19**	**17**	**6**	**14**	**9**	**1**	**3**	**72**

IVD = intervertebral disc; SI = sacroiliac; TB = Tuberculosis

Table 4.3 Primary clinical diagnosis versus a combination of primary and secondary radiographic diagnoses

Primary Clinical Diagnosis	Primary and Secondary Radiographic Diagnosis												
	Congenital	Compression Fracture	Increased lordosis	Loss of lordosis	Normal No secondary diagnosis		Old trauma	Osteoporosis	Scoliosis	Spinal stenosis	Spondylolisthesis	Spondylosis	**Total**
Suspected cancer	0	0	0	0	0	1	0	1	0	0	0	2	**4**
Claudication	0	0	0	0	0	0	1	0	0	0	0	1	**2**
Coccydynia	0	0	0	1	0	0	0	0	0	0	0	1	**2**
Instability of the lumbar spine	0	0	0	1	0	0	0	0	1	0	0	0	**2**
IVD herniation	0	0	0	3	0	2	1	0	3	0	0	3	**12**
Lumbar facet syndrome	1	0	3	6	1	8	4	6	8	0	0	13	**50**
Lumbar paraspinal myofasciitis	0	0	0	0	0	1	1	0	3	0	0	3	**8**
No diagnosis	0	0	0	1	0	1	0	1	0	0	0	1	**4**
SI syndrome	0	1	1	10	0	4	4	5	5	1	4	19	**54**
Spondylolisthesis	0	0	0	1	0	0	1	0	0	0	0	0	**2**
Spondylosis	0	0	0	0	0	0	0	2	1	0	0	3	**6**
TB of the spine	0	0	0	1	0	0	0	0	1	0	0	0	**2**
Total	**1**	**1**	**4**	**24**	**1**	**17**	**12**	**15**	**22**	**1**	**4**	**46**	**148**

IVD = intervertebral disc; SI = sacroiliac; TB = Tuberculosis

4.3 THE CONSULTATION WHEN A LUMBAR SPINE X-RAY WAS REQUESTED AND THE REASONS THEREOF

The consultation at which a lumbar spine x-ray was requested by the student or clinician and the reasons thereof are shown in **Table 4.4**. The majority of lumbar spine x-rays were requested at the initial consultation and the trend was for the frequency of x-ray requests to decrease as the length of treatment increased. It is interesting to note that no lumbar spine x-rays were requested at treatment numbers six and eight.

The most common reasons for x-ray referral were to evaluate for unspecified pathology, degenerative changes and fracture (**Table 4.4**). 'Unspecified pathology' refers to a pathology that was suspected by the student or clinician but they did not clearly state which pathologies they suspected on the x-ray request forms. This 'unspecified pathology'

is to be differentiated from 'no reason provided'. In this category, a lumbar spine x-ray was requested but there were absolutely no reasons or suspected diagnoses written on the x-ray request form that would indicate what the clinician or student was expecting to find upon examination of the x-ray films. This was a common finding in this study group, with 21.6% (*n* = 16) lumbar spine x-rays requested without providing any reason why this type of imaging technique was required. Interestingly, only one x-ray was requested to evaluate why the patient was not responding to the treatment. This was done at treatment number seven.

Table 4.4 A summary of the consultations at which lumbar x-rays were requested and the reasons thereof

Treatment number	Frequency	Percent	Reason for x-ray request
1	50	67.6	• Unspecified pathology (20.7%) • Degeneration (15.9%) • No reason provided (14.6%) • Fracture (12%) • Stenosis (6.1%) • Spondylolisthesis (4.9%) • NRE and suspected IVD herniation (3.7% each) • Trauma, metastases and OA of the hip (2.4% each) • Sacroilliitis, calcification of the abdominal aorta, instability, skeletal malalignment, sacroiliac pathology, TB, previous coccyx displacement, unspecified bony abnormalities and growth plate injuries (1.2% each)
2	9	12.2	• Degeneration (27.8%) • Unspecified pathology (16.7%) • No reason provided and fracture (11% each) • Abscess, NRE, osteoporosis, trauma, space occupying lesion and stenosis (5.6% each)
3	4	5.4	• Degeneration (37.5%) • Suspected IVD herniation (25% each) • Instability, unspecified pathology and no reason provided (12.5% each)
4	5	6.8	• Unspecified pathology (33.3%) • Trauma (22.2%) • Fracture, no reason provided, instability and calcification of the abdominal aorta (11% each)

5	2	2.7	• Degeneration, spondylolisthesis, suspected IVD herniation and space occupying lesion (25% each)
7	1	1.4	• No response to treatment
9	2	2.7	• Degeneration (40%) • Unspecified pathology, fracture and instability (20% each)
10	1	1.4	• Degeneration
Total	74	100.0	

NRE = nerve root entrapment; IVD = intervertebral disc; OA = osteoarthritis; TB = tuberculosis

4.4 SUSPECTED CLINICAL DIAGNOSES AND MANAGEMENT PRIOR TO REFERRAL FOR LUMBAR SPINE X-RAYS

The management options for each of the suspected clinical diagnoses are summarised in **Table 4.5**. The results show that a broad spectrum of treatment approaches was utilised for these conditions. Manual therapy included lumbar spine or sacroiliac joint manipulation, mobilisation or pelvic blocking. The proportion of spinal manipulation to other forms of manual therapies is shown in **Figure 4.2**. Soft tissue therapy involved modalities such as massage, ischaemic compression, “grip and rip” and dry needling of myofascial trigger points of the lumbar paraspinal musculature. Interferential current therapy (IFC), transcutaneous electrical nerve stimulation (TENS), ultrasound or action potential stimulation (APS) encompassed the electrotherapy modalities that were used in the treatment of patients presenting with low back pain. Stretching or strengthening included proprioceptive neuromuscular facilitation stretches (PNF), static stretches or strengthening exercises. Heat, ice or traction were grouped in the category ‘other’ (**Table 4.5; Figure 4.2**).

Manual therapies, stretching or strengthening exercises, massage and electrotherapy were the predominant modalities utilised to treat patients with low back pain prior to requesting x-rays (**Figure 4.2**). Interestingly, the two patients suspected with the red flag conditions, TB of the spine and suspected cancer, were managed in a contrasting manner (**Table 4.5**). The patient suspected of TB of the spine did not receive any treatment prior to the availability of the radiographic report while the patient who was suspected of having cancer received soft tissue therapy and stretching or strengthening exercises before the x-ray was requested.

Table 4.5 Suspected clinical diagnosis and management prior to x-rays

	Manual therapy	Soft tissue therapy	Electrotherapy	Stretching or strengthening	No treatment, pending x-ray results	Other
Sacroiliac syndrome	✓	✓	✓	✓	✓	✓
Lumbar facet syndrome	✓	✓	✓	✓	✓	✓
Lumbar paraspinal myofasciitis	✗	✓	✓	✓	✓	✓
IVD herniation	✓	✓	✓	✓	✓	✓
Spondylolisthesis	✓	✓	✓	✓	✓	✗
Claudication (neurogenic or vascular)	✗	✓	✗	✓	✓	✗
Spondylolysis	✓	✓	✓	✓	✓	✗
Coccydynia	✗	✓	✓	✓	✗	✓
Diagnosis pending x-ray results	✗	✓	✓	✓	✓	✓
TB of the spine	✗	✗	✗	✗	✓	✗
Suspected cancer	✗	✓	✗	✓	✗	✗

IVD = intervertebral disc; TB = Tuberculosis; ✓= modality was utilised in treatment; ✗= modality was not utilised in treatment

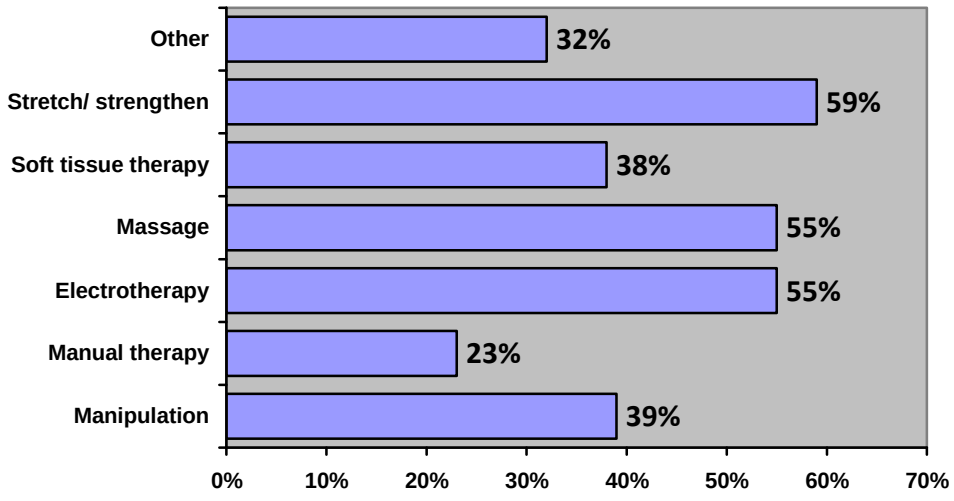


Figure 4.2 Management prior to x-rays

4.5 CHANGES IN CLINICAL DIAGNOSIS AND MANAGEMENT AFTER X-RAYS

There were 30 patients (40.5%) who had a change in diagnosis following x-ray examination (**Table 4.6**) and 62 (84%) who had a change in treatment after x-ray (**Table 4.3**).

The trend observed shows that even though the suspected clinical diagnosis may have changed, it usually changed to a non-specific mechanical cause for low back pain. The most common of these diagnoses were sacroiliac syndrome, lumbar facet syndrome and myofasciitis.

Of the 74 patients in this study, 44 patients did not have a change in diagnosis, which means that 59.5% of the diagnoses remained the same after x-ray examination. Changes in the management of patients following x-ray examination are shown in **Figure 4.3**. Manipulation was utilised as a treatment modality more frequently (62%) after x-rays were obtained than before x-rays were taken (39%). All modalities across the treatment spectrum were utilised more often with only the use of the electrotherapies staying the same at 55%. This is evident when comparing the results of **Figures 4.2** and **4.3**.

Table 4.6 Details of change of diagnosis

Suspected clinical diagnosis	X-ray diagnosis	New diagnosis
Suspected cancer	• Spondylosis (33.3%) • Osteoporosis (33.3%) • Postural disturbance due to mild scoliosis or hyper/hypolordosis (33.3%)	• Myofasciitis (50%) • Spondylitic changes (50%)
Neurogenic/ vascular claudication	• Suspected IVD protrusion (33.3%) • Spondylosis (33.3%) • Old trauma (33.3%)	• Myofasciitis
Instability of the lumbar spine	• Postural disturbance due to mild scoliosis or hyper/hypolordosis	• Sacroiliac syndrome (50%) • Myofasciitis (50%)
Suspected lumbar IVD herniation	• Degenerative disc disease (40%) • Old trauma (20%) • Spondylosis (20%) • Postural disturbance due to mild scoliosis or hyper/hypolordosis (20%)	• Lumbar facet syndrome (30%) • Sacroiliac syndrome (30%) • Myofasciitis (20%) • Reflex sympathetic dystrophy (10%) • IVD herniation (10%)
Lumbar facet syndrome (including Maigne's syndrome)	• Degenerative disc disease (23.8%) • Postural disturbance due to mild scoliosis or hyper/hypolordosis (19.0%) • Spondylosis (19.0%) • Osteoporosis (14.3%) • Spondylolisthesis (4.8%) • Old trauma (4.8%) • Scoliosis (4.8%) • Normal (4.8%) • Suspected IVD protrusion (4.8%)	• Myofasciitis (31.3%) • IVD herniation (25%) • Lumbar facet syndrome (18.8%) • Spondylosis (12.5%) • Sacroiliitis (6.2%) • Sacroiliac syndrome (6.2%)
Lumbar paraspinal myofasciitis	• Postural disturbance due to mild scoliosis or hyper/hypolordosis	• Lumbar facet syndrome (50%) • Myofasciitis (50%)
Diagnosis pending x-ray results	• Postural disturbance due to mild scoliosis or hyper/hypolordosis (25%) • Degenerative disc disease (25%)	• Myofasciitis (33.3%) • Lumbar facet syndrome (33.3%)

	• Spondylolisthesis (25%) • Osteoporosis (25%)	• Spondylosis (33.3%)
Sacroiliac syndrome	• Spondylosis (30.8%) • Postural disturbance due to mild scoliosis or hyper/hypolordosis (30.8%) • Degenerative disc disease (7.7%) • Osteoporosis (7.7%) • Old trauma (7.7%)	• Sacroiliac syndrome (27.3%) • Lumbar facet syndrome (27.3%) • Myofasciitis (27.3%) • Anterior hip capsulitis (9.1%) • Ischial tuberosity bursitis (9.1%)
Spondylolisthesis	• Old trauma (66.6%) • Postural disturbance due to mild scoliosis or hyper/hypolordosis (33.3%)	• Sacroiliac syndrome (33.3%) • Lumbar facet syndrome (33.3%) • Myofasciitis (33.3%)
Spondylosis	• Degenerative disc disease (25%) • Osteoporosis (25%) • Old trauma (25%) • Spondylosis (12.5%) • Scoliosis (12.5%)	• Sacroiliac syndrome (25%) • Myofasciitis (25%) • NRE (25%) • Spondylosis (25%)
TB of the spine	• Old trauma (50%) • Postural disturbance due to mild scoliosis or hyper/hypolordosis (50%)	• Myofasciitis

IVD = intervertebral disc; TB = Tuberculosis; NRE = nerve root entrapment

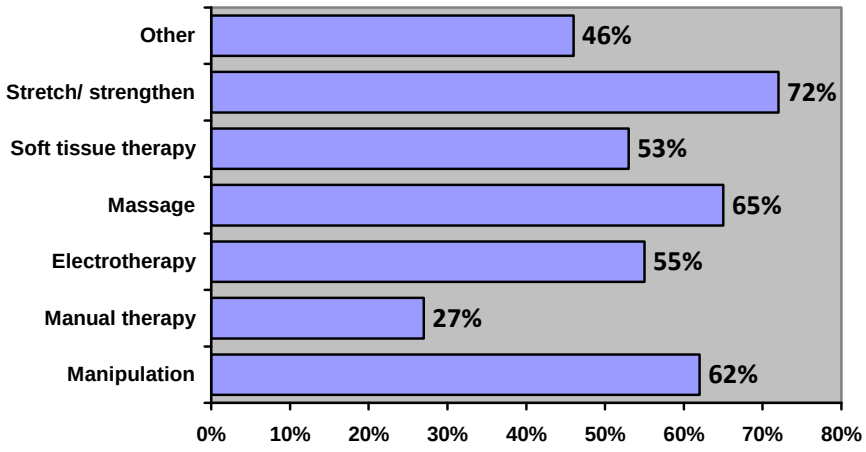


Figure 4.3 Management of the patients after lumbar spine x-rays were obtained

4.6 INCIDENTAL RADIOGRAPHIC FINDINGS

There were 27 (36.5%) incidental findings observed in the 74 lumbar spine x-rays with 23% (*n* = 17) relating to abnormalities of the abdominal aorta. The incidental findings were most commonly observed in patients diagnosed with lumbar facet syndrome, sacroiliac syndrome and myofasciitis (**Table 4.7**). Possibly the most serious of all the incidental findings in this sample is the suspected aneurysm of the abdominal aorta. There was a relatively high number of transitional vertebrae (12.2% or *n* = 9) present in this sample as shown in **Table 4.7**. There were 55.6% of lumbarisation and 44.4% of sacralisation observed in the nine cases of transitional vertebrae.

Table 4.7 Incidental findings and related suspected clinical diagnoses

Incidental finding	Frequency	Percent	Suspected Clinical Diagnosis (with percentages)
Atheroma of the abdominal aorta	16	21.6	• Lumbar facet syndrome (26.3%) • SI syndrome (21.1%) • Lumbar paraspinal myofasciitis (18.4%) • Neurogenic/vascular claudication, degenerative joint disease and lateral/central canal stenosis (5.3% each) • NRE, trochanteric bursitis, traumatic, IVD herniation, cancer, OA of the hips and diagnosis pending x-ray results (2.6% each)
Aneurysm of the abdominal aorta	1	1.35	• SI syndrome
Calcified mesenteric lymph nodes	1	1.35	• Spondylolysis • Suspected fracture
Transitional vertebrae	9	12.2	• Lumbar paraspinal myofasciitis (33.3%) • Lumbar facet syndrome and SI syndrome (20% each) • IVD bulge/herniation (13.3%) • Spondylolisthesis and NRE (6.6%)
Total	27	36.5	

SI = sacroiliac; NRE = nerve root entrapment; IVD = intervertebral disc; OA = osteoarthritis

CHAPTER FIVE

DISCUSSION OF RESULTS

5.1 AGE AND GENDER

The mean age (±SD) of the participants in this study was 43.9 (±16.9) years. Although this figure is comparable to the mean age of patients (36.5 years) presenting at American Chiropractic Colleges (Waalen *et al.*, 1994), it was more in keeping with the average age of patients treated in private chiropractic practices in America, which was 46 years. The age range of patients in this study was not as wide as that reported by Waalen *et al.* (1994). They treated patients as young as one-year old and as old as 93 years. This suggests that very young and very old patients do not come for treatment at the CDC but this conclusion would be erroneous as this study focussed only on those patients who presented with low back pain and had x-rays taken at some point in their management. The number of male and female patients was approximately equal (**Figure 4.1**) in keeping with the findings of Waalen *et al.* (1994).

5.2 THE RELATIONSHIP BETWEEN THE CLINICAL AND THE RADIOGRAPHIC DIAGNOSES OF PATIENTS WITH LOW BACK PAIN

The attempts at correlating the clinical and the radiographic diagnoses of low back pain were unsuccessful because there were too many variables for any statistical test to be performed. The main reason for this was that the clinical diagnoses recorded were not the same as the radiographic diagnoses. It appears as if there is no relationship between the two diagnoses and this may lead to a number of possible scenarios. Either the x-ray examination results were non-diagnostic, or the x-ray examination results were not included in the eventual diagnosis, or the initial clinical diagnosis was incorrect. This highlights a problem with the diagnostic process of low back pain in patients presenting at

the CDC. The results of this study also show that there may be an over-reliance on x-rays by students to arrive at a diagnosis, possibly due to a lack of confidence in making a clinical diagnosis especially as these students have not yet had sufficient clinical experience.

Four patients were not diagnosed clinically before x-rays were taken (**Table 4.3**). They had 'diagnosis pending x-ray results' written in their files and their x-ray request forms were devoid of any reason to request this type of imaging. This raises an ethical question of whether it is appropriate to x-ray patients if there is no strong clinical suspicion of what results are expected, conversely x-ray examination may clarify a patient's condition. The accepted view is that is unethical to x-ray patients if there are no valid reasons for doing so (Simmons *et al.*, 1995; Patel and Ogle, 2000; Atlas and Nardin, 2003; Chiropractic Clinic Manual, 2010). On the other hand, patients should not undergo manual treatment, especially manipulation, if there is clinical diagnostic uncertainty and at least an x-ray examination may indicate a contraindication to treatment. Thus a management protocol could not be initiated in these cases as the clinical entity was unknown. Following imaging, these patients were found to have radiographic evidence of a loss of lumbar lordosis or spondylosis (**Table 4.3**). These are not classified as pathological conditions and the researcher could not find any plausible explanations in any of the clinical notes as to why these patients were managed in such a manner.

In this study the terms 'spondylosis' and 'degeneration' were used interchangeably as no clear definitions of these terms could be discerned from the literature (van Tulder *et al.,* 1997; Thomas, 2004; Rowe and Yochum, 2005; Stedman's Medical Dictionary, 2005). Spondylosis was the most common radiographic finding in this sample and this may be attributed to the higher average age of the patients in this sample. A loss of lumbar lordosis and scoliosis were also common radiographic findings. The most common clinical diagnoses were lumbar facet and sacroiliac syndromes. The large percentage of patients diagnosed with these mechanical disorders may represent an over reliance on these and could also indicate a diagnosis of convenience. This finding may also be attributed to the fact that the CDC is a chiropractic clinic and so the diagnosis reflects what was actually being treated at that time. The assumption is made that more severe cases would present to a hospital before a chiropractic clinic.

Malanga and Chimes (2008) reported that lumbar facet syndrome occurs as a result of degeneration in the facet joint or in the intervertebral discs and this may explain the relationship between those patients who were diagnosed with lumbar facet syndrome who

had spondylitic changes diagnosed upon x-ray examination (**Table 4.1**). This observation also emphasises the difficulty in reaching a definitive diagnosis in low back pain (Pederson *et al.*, 1992; van Tulder *et al.*, 1997). Cohen (2005) reported that risk factors that predispose an individual to sacroiliac syndrome include leg length discrepancy, gait abnormalities, scoliosis, spinal fusion and prolonged vigorous exercise. This observation is supported in part by the results shown in **Table 4.3** in the case of the relationship between scoliosis and sacroiliac syndrome. The results presented in **Table 4.3** also show that sacroiliac syndrome was related to the radiographic findings of spondylosis (35%), a loss of lumbar lordosis (18.5%) and osteoporosis (9.2%). Curvature problems, particularly loss of lumbar lordosis and scoliosis were commonly seen in patients diagnosed with either lumbar facet or sacroiliac syndromes. This finding may be explained, in part, by the presence of lumbar paraspinal myofasciitis which is commonly associated with these syndromes (Kirkaldy-Willis and Bernard, 1999; Travell and Simons, 1999).

The cases of suspected cancer (n = 2) and TB (n = 1) of the spine did not have any significant findings on x-ray evaluation. This, however, may have been due to the radiographic latent period of these disease entities or they might have been present in anatomic locations other than the spine (Yochum and Rowe, 2005). Therefore, these patients should have been referred to their medical practitioners for an assessment of their suspected clinical condition, but it was not recorded in their patient files whether this occurred. This observation also highlights the importance of keeping complete patient records especially bearing in mind the area of possible medicolegal challenges at a later stage.

5.3 THE CONSULTATION WHEN A LUMBAR SPINE X-RAY WAS REQUESTED AND THE REASONS THEREOF

It is important to acknowledge that initial medical treatment for acute low back pain is usually in the form of medication which, obviously, does not use mechanical forces applied to the spine. Therefore, evidence-based medicine states that x-rays should not be taken in the acute phase of low back pain unless in the presence of red flags or if the patient is not responding to a trial of adequate treatment which usually lasts four to six weeks (Patel and Ogle, 2000; Malanga and Chimes, 2008). However, chiropractic treatment frequently uses the application of mechanical forces to the lumbar spine. It is, therefore, particularly interesting to note that the majority of lumbar spine x-rays in this

sample were obtained after the first consultation (**Table 4.4**). No suitable reason for obtaining the x-ray was provided in 14.6% of the x-rays requested and 20.7% were requested to examine for an unspecified pathology. Furthermore, failing to provide a reason for requesting lumbar spine x-rays or simply stating 'unspecified pathology' on an x-ray request form are not proper indications (**Table 2.4**) for requesting x-rays. Therefore, these requests were contrary to the internationally accepted evidence-based medical guidelines (Simmons *et al.*, 1995; Atlas and Nardin, 2003) even though these guidelines also appear in the DUT Chiropractic Clinic Manual (Chiropractic Clinic Manual, 2010).

One of the major roles of the supervising clinicians is to guide the students in making clinically accurate diagnoses and to advise the student on the appropriate use of diagnostic tests, including the use of plain film radiography. The CDC Radiographic Guidelines and Procedures (Chiropractic Clinic Manual, 2010) state that x-rays should be used to confirm or reject a clinical impression based on a thorough history and physical examination. It is particularly interesting to see this large number of unsuitable referrals for x-ray examination when one takes into account that these forms need to be signed-off by the supervising clinician before the x-rays can be taken. The findings of this study should, therefore, be presented to the panel of the clinicians and students at the CDC with the view to improving the clinical practice at the CDC in line with internationally accepted standards.

Two of the limitations of radiography are the poor visualisation of soft tissue structures and the radiographic latent period for tumours and infections (Yochum and Rowe, 2005). However, in this study, x-rays were used as the primary means of investigation for a variety of conditions including intervertebral disc herniations, central and lateral canal stenosis, nerve root entrapments, TB, abscesses, space occupying lesions, calcification of the abdominal aorta and metastases (**Table 4.4**). This may represent an inappropriate use of radiography as plain film radiographs may miss early tumours and infections and cannot diagnose intervertebral disc herniations or non-osseous causes of spinal stenosis (Atlas and Nardin, 2003). Other diagnostic investigations such as diagnostic ultrasound or MRI following a referral to a medical practitioner may have been more appropriate for some of these patients. Furthermore, no reasons were given as to the likely locations of the space occupying lesions or abscesses (**Table 4.4**). The information in the patient file was unclear as to why calcification of the abdominal aorta was suspected in the patient who had no red flags after examination and why x-rays were utilised to detect it. This patient's x-rays showed spondylosis, spondylolisthesis, stenosis, a mild scoliosis and there were suspicions of an aneurysm of the abdominal aorta. It is, therefore, possible that

the student incorrectly recorded a suspicion of calcification of the abdominal aorta instead of a suspicion of an abdominal aortic aneurysm. Although an abdominal aortic aneurysm has prognostic significance depending on its diameter, the patient was not sent for any further investigations into the suspected aneurysm and no reasons were recorded on the clinical notes.

Fracture, trauma, metastases, TB, growth plate injuries and no response to treatment (**Table 4.4**) were red flag conditions that were identified in this study. All of these patients were sent for plain film radiography as a base line investigation. However, the cases of TB, metastases and growth plate injury in a ten year old patient, respectively would have been managed better if they were referred for medical treatment and further investigations before any treatment was undertaken at the CDC. The presence of any of these red flag conditions may drastically alter the treatment and management strategies of the patient (Sherman, 1986). Haldeman (1999) stresses the importance of identifying and correctly managing red flag conditions because of their dire consequences which may leave the patient with permanent deficits.

One x-ray was requested at treatment seven because the patient was not responding to treatment. Prior to x-rays, the patient was diagnosed with lumbar facet syndrome with concomitant sacroiliac syndrome and there were no red flags identified. The treatment included manipulative therapy and massage which was consistent with the recommendations of Kirkaldy-Willis and Bernard (1999) and Souza (2009) that conservative treatment is appropriate for these conditions. Failure to respond to adequate treatment is a valid reason to request x-rays (Patel and Ogle, 2000). In this case, the x-ray examination revealed an old pars fracture at L5, spondylosis and a mild scoliosis. This radiographic finding did not influence a change in the diagnosis nor the treatment plan for the patient. It is worthy to note that this is the only instance when x-rays were taken to check the progress of the disease or why the patient was not responding to treatment, even when some patients were treated ten or more times. This apparent over-reliance on and inappropriate use of lumbar spine x-rays at the CDC may be attributed to the fact that some CDC patients are offered x-rays free of charge at the Radiographic Clinic at the same institution. This easy access to and the low or no cost of x-rays may lead to the abuse of the facility, even though there was no financial incentive for the clinicians or students to order x-rays as is the case in some private settings. It may also indicate the students' lack of confidence in making the clinical diagnosis and so they utilise x-rays to compensate for their low confidence.

The apparent overuse of x-rays at this clinic may also be attributed to cost factors, as the CDC is a teaching clinic it attracts a lower income bracket of patients and patients who do not have a medical aid. Many of the bony red flag conditions would be better visualised on CT scans, but the costs would be prohibitive and this may possibly have led to more x-ray examinations being requested so that some visualisation of the structure in question was obtained.

5.4 THE SUSPECTED CLINICAL DIAGNOSES AND MANAGEMENT PRIOR TO REFERRAL FOR LUMBAR SPINE X-RAYS

The majority of patients were diagnosed with mechanical or non-specific low back pain, especially lumbar facet syndrome, sacroiliac syndrome, intervertebral disc herniations and lumbar paraspinal myofasciitis. This is in agreement with the findings reported by Kent and Keating (2004) that approximately 80% of low back pain patients have mechanical aetiologies for their pain. The patient with the primary diagnosis of coccydynia seems to be out of place, especially as lumbar spine x-rays were requested even though they do not usually include visualisation of the coccyx. There were two patients who were not diagnosed clinically as it was recorded that the diagnosis was pending the x-ray results (**Table 4.1**). These patients were later diagnosed with mechanical aetiologies of their low back pain.

A wide range of treatment modalities were employed in the treatment of the patients. The use of manipulation and other manual therapies was not as high as the use of soft tissue therapies and electrotherapies. This may represent a more conservative approach to the treatment of the patients before x-rays were obtained. Lumbar facet syndrome, sacroiliac syndrome and intervertebral disc herniations were the only conditions that were treated using the full range of therapeutic modalities available at the CDC. This observation shows that the treatments employed for the various diagnoses is not vastly different and questions why a specific diagnosis is important for non-specific causes of low back pain if these conditions are treated in a similar manner. It was also observed that when the diagnosis was pending x-ray results, the patients were treated using exactly the same treatment modalities, with the exception of manual therapy (**Table 4.5**).

It is also interesting to observe the different treatment strategies for the red flag conditions of suspected cancer and TB. The TB patient did not receive any treatment prior to the request for x-rays, whilst the suspected malignancy patient received soft tissue therapy

and stretching or strengthening exercises before diagnostic imaging was requested. According to the management protocol described by Souza (2009) and the algorithm presented in **Figure 2.1** the first step in the diagnostic process is to evaluate for tumour, infection or fracture and refer for medical assessment and management if necessary. Neither of these cases was referred for further diagnostic examination and medical management.

In summary, prior to being sent for x-rays, the majority of patients were diagnosed with mechanical aetiologies of low back pain. There were two red flag cases identified and two patients were not clinically diagnosed prior to x-ray evaluation. Most patients received some form of conservative therapy but the use of manual therapy was limited. The red flag cases were not sent for further medical evaluation.

5.5 CHANGES IN CLINICAL DIAGNOSIS AND MANAGEMENT AFTER X-RAYS

Of the 74 patients in this study, 44 patients did not have a change in diagnosis, a figure comparable to Scavone *et al.*'s (1981) finding, which means that 59.5% of the diagnoses remained the same after x-ray examination. However, in 30 patients (40.5%) at the CDC the diagnosis was changed, leading to greater use of manipulation (62%) versus 39% prior to x-ray imaging, suggesting the students felt more confident using spinal manipulation knowing what imaging showed – a commendable approach. Scavone *et al.* (1981) showed that at their institution, lumbar spine films yielded insignificant or non-diagnostic information in more than 50% of the cases, and they believed that this high percentage of unproductive studies indicated an overuse of x-rays at their medical treatment facility.

The trend in the clinical diagnoses is similar in the two groups viz. the group where the diagnosis did not change compared to the group where the diagnosis did change (**Table 4.6**) as most of the diagnoses were of the non-specific mechanical causes of low back pain. It is also observed that there were few red flag conditions diagnosed which is in keeping with the findings of Kent and Keating (2004) who reported that approximately 80% of low back pain patients have non-specific or mechanical low back pain and the remaining 20% have specific low back pain, which may be due to a serious pathology. The radiographs of the patient who was suspected of having cancer showed osteoporosis, degeneration and postural disturbance but was otherwise normal. Following this, the

clinical diagnosis was changed to that of myofasciitis with some spondylitic changes, indicating that the red flag condition was now excluded from the differential diagnosis. Similarly, the patients suspected with TB of the spine and neurogenic/vascular claudication were diagnosed with myofasciitis after x-ray evaluation. It is not indicated in the clinical records why reflex sympathetic dystrophy was included as a co-diagnosis following radiographic examination in the patient who was originally diagnosed with an intervertebral disc herniation. Even when the student or clinician was unsure of a diagnosis and wrote 'diagnosis pending x-ray results' in the patient's file, the patients were diagnosed with a non-specific mechanical aetiology for their low back pain following radiographic examination.

Diagnoses that were not suspected clinically but were observed after x-ray evaluation include suspected intervertebral disc herniation and osteoporosis. It was observed that 16 patients (21.6%) had some degree of osteoporosis evident on x-ray examination. Although osteoporotic fractures are included as a mechanical cause of low back pain (**Table 2.2**) they were not recorded as a clinical diagnosis in the patient records (following radiographic examination). Instead other causes of mechanical low back pain were recorded. It should, however, be noted that a radiographic diagnosis of osteoporosis is open to interpretation especially in mild to moderate cases and require special tests such as a bone densitometry scan to confirm the diagnosis (Yochum and Rowe, 2005). When a clinical diagnosis was changed, it was changed either to a new diagnosis or it remained the same, but had a concomitant condition added to it. For example, the clinical diagnosis may have been sacroiliac syndrome which was later changed to a sacroiliac syndrome with concomitant myofasciitis or sacroiliac syndrome with concomitant lumbar facet syndrome although this made no significant difference to the management of the patient.

All of the modalities were utilised more frequently after x-ray examination, with the exception of electrotherapy which remained the same (**Figure 4.3**). The most common treatment modality utilised both before and after x-rays was stretching or strengthening exercises. The use of manipulation increased from 39% prior to radiographic examination to 62% following radiographic examination (**Figure 4.3**). The increase in the use of manipulation after x-rays could indicate an initial conservative approach to the use of manipulation which was relaxed once the patient had been screened for the more serious causes of low back pain. It is interesting to note that at the CDC, the most commonly used treatment modalities observed were stretching or strengthening exercises and massage. One would have expected manipulative therapy to be the principal treatment modality at the CDC. Instead, it is only the third most common treatment modality. This may represent

a more conservative approach used by the students or a possible lack of confidence in their manipulative techniques. This finding may be of interest to instructors in manipulative techniques at the Department of Chiropractic and Somatology, DUT, as it may help them to prepare useful strategies to instil confidence in the students with regard to their manipulative techniques.

5.6 INCIDENTAL RADIOGRAPHIC FINDINGS

Incidental findings were observed in 36.5% of the lumbar spine x-rays in this study (**Table 4.7**) which is more than twice the 16.2% for musculoskeletal conditions reported by Lumbreras *et al.* (2010). Soft tissue abnormalities were observed in 13.5% of patients (Beck *et al.,* 2004), but in this study a higher figure was observed, with 23% of the patients having abnormalities of the abdominal aorta detected on radiographs. Transitional vertebrae were observed in 12.2% of the patients which is higher than that reported by Beck *et al.* (2004) (7.8%) but is similar to the findings of a previous study conducted at the CDC by Pillay (2007) who observed that transitional vertebrae were the most common lumbar spinal anomalies (11.9%).

Guebert *et al.* (2005) reported that structural problems found at the level above lumbar transitional segments include altered biomechanics, intervertebral disc bulges or herniations, annular tears in the intervertebral disc, central or lateral canal stenosis, facet arthritis and spondylolysis. In this study transitional vertebrae were mostly found in patients who were clinically diagnosed with lumbar paraspinal myofasciitis, lumbar facet syndrome and sacroiliac syndrome. This may be due to the similar clinical presentation of transitional vertebrae to those of other mechanical aetiologies of low back pain. Lumbar paraspinal myofasciitis may result in scoliosis and hyper/hypolordosis (Travell and Simons, 1999) while transitional segments are related to altered biomechanics. Facet arthritis and lumbar intervertebral disc bulges or herniations are both thought to be aetiologies of lumbar facet syndrome (Malanga and Chimes, 2008). The pain referral pattern of sacroiliac syndrome is often indistinguishable from that of a herniated lumbar intervertebral disc and altered biomechanics, such as leg length discrepancy, gait abnormalities and scoliosis may predispose to the development of sacroiliac syndrome (Cohen, 2005).

Possibly the most serious of all the incidental findings reported in the results (**Table 4.7**), is the suspected aneurysm of the abdominal aorta. It is interesting to note that this

diagnosis was not confirmed by diagnostic ultrasound and no reasons for this are recorded in the patient file. The treatment prior to radiographic examination included sacroiliac mobilisation, APS therapy with the addition of heat following radiographic examination. The management of this patient may have been inappropriate as further investigations should have been instituted before continuing with any treatment for the low back pain.

5.7 PROPOSED RECOMMENDATIONS FOR THE CHIROPRACTIC DAY CLINIC

The following recommendations are proposed for the CDC based on the results of this study:

- The clinicians should ensure that the students validate their clinical diagnosis based on sound history and physical examination findings and bear in mind the important role of x-ray evaluation.

- Students at the CDC should be encouraged to explore other diagnoses of low back pain rather than over-relying on the broad spectrum of mechanical low back pain diagnoses, especially lumbar facet and sacroiliac joint syndromes.

- Clinicians and students should adhere to the accepted guidelines for ordering x-rays to assist in the diagnosis of low back pain. Radiographic request forms should never include ‘no diagnosis’ or ‘unspecified pathology’ as a reason for ordering x-rays. Furthermore, x-rays should only be requested at the initial consultation if there is a genuine need for them e.g. red flags (Simmons *et al.*, 1995; Atlas and Nardin, 2003).

- Patients with red flags in their history and/or physical examination findings should be referred to appropriate medical practitioners for further evaluation. These patients should never be treated at the CDC if this is not done.

- Clinicians and students should be aware that red flag conditions such as TB and cancer may not be clearly evident on x-rays. This may be due to the radiographic latent period or early stage of the clinical entity. Therefore, these patients should be evaluated on a regular basis, by the students, for the possible appearance of

any red flags. A second opinion should be sought from experienced medical practitioners if there is any doubt of the diagnosis.

- If a clinical diagnosis is changed, whether through the physical or radiographic examination findings, this needs to be properly documented in the SOAPE note in the patient's file. This is important for medicolegal reasons.

- Spinal manipulation should be encouraged as the primary treatment modality for mechanical or non-specific causes of low back pain as several studies have reported its efficacy in the treatment of mechanical low back pain (Atlas and Nardin, 2003; Moffett and McLean, 2006; Souza, 2009). (It should never be utilised as a modality for the treatment of low back pain of pathological origin).

- Students should be encouraged to motivate their treatment plans based on evidence-based guidelines.

- Strategies to instil confidence in students on their manipulative techniques should be instituted by the relevant technique instructors and supported by the clinicians.

- Students should be exposed to a multidisciplinary setting or hospital where a multitude of specialists are available. This would most likely improve the student's thinking in terms of the aetiology, diagnosis and management of low back pain patients. A possible short term solution would be to have specialists other than chiropractors acting as teaching clinicians.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

The majority of the lumbar spine x-rays taken at the CDC were requested at the first consultation with the patient. No suitable reason for obtaining the x-ray was provided in 14.6% of the x-rays requested and 20.7% were requested to examine for an unspecified pathology. This goes against the evidence-based guidelines for requesting x-rays and may indicate that the students lack confidence in their clinical diagnoses. It was also observed that x-rays were not influential in changing the clinical diagnosis in 44 (59.9%) of the cases. However, the x-ray examination did change the clinical diagnosis in 30 (40.5%) of cases, a not insignificant number of cases. This, in turn, lead to a greater use (62%) of spinal manipulation versus only 39% prior to imaging.

This suggests that the students felt more confident about using spinal manipulation that involves mechanical forces applied to the spine once they knew what a patient's spine looked like on imaging. As manipulation has been shown to be a very effective form of treatment in some cases of low back pian, it raises the question of ethics in withholding such treatment from a patient simply because the patient has not had imaging as a precaution. Perhaps the role of imaging in low back pain cases requires re-evaluation at the CDC.

Most patients were diagnosed with the non-specific mechanical causes of low back pain, even in the presence of red flags. This not only highlights that these may be a diagnosis of convenience utilised by the students, especially in the cases of lumbar facet and sacroiliac syndromes but also the danger of ignoring or diluting the significance of red flags. The management of the patients did not differ significantly before and after x-rays and this may indicate that x-rays are not influential in changing the management of the patients at the CDC.

6.2 RECOMMENDATIONS

Recommendations for future studies include the following:

- A similar study should be conducted at the Chiropractic Clinic at the University of Johannesburg to determine whether these findings are similar to those of another chiropractic teaching clinic in South Africa or are unique to the CDC.
- This study could also be conducted with a sample of private chiropractic practices. This would enable a comparison to be made between the academic environment of the teaching clinics and the environment of private practice.

It is recommended that the findings of this study be presented to the panel of clinicians and the students at the CDC with the view to improving the clinical practice at the CDC in line with internationally-accepted standards.

LIST OF REFERENCES

1. Ammendolia, C., Cote, P., Hogg-Johnson, S. and Bombardier, C. 2007. Do chiropractors adhere to guidelines for back radiographs? *Spine*, 32(22): 2509-2514.

2. Atlas, S.J. and Deyo, R.A. 2001. Evaluating and managing acute low back pain in the primary care setting. *Journal of General Internal Medicine*, 16: 120-131.

3. Atlas, S.J. and Nardin, R.A. 2003. Evaluation and treatment of low back pain: an evidence-based approach to clinical care. *Muscle and Nerve*, 27: 265-284.

4. Beck, R.W., Holt, K.R., Fox, M.A. and Hurtgen-grace, K.L. 2004. Radiographic anomalies that may alter chiropractic intervention strategies found in a New Zealand population. *Journal of Manipulative and Physiologic Therapeutics*, 27(9): 554-559.

5. Biering-Sørensen, F., Hansen, FR., Schroll, M. and Runeborg, O. 1985.The relation of spinal X-ray to low-back pain and physical activity among 60-year old men and women. *Spine,* 10: 445-451.

6. Borkan, J., Van Tulder, M., Reis, S., Schoene, M.L., Croft, P. and Hermoni, D. 2002. Advances in the field of low back pain in primary care: a report from the fourth international forum. *Spine,* 27(5): E128-E132.

7. Carey, T.S. and Garrett, J. 1996. Patterns of ordering diagnostic tests for patients with acute low back pain. *Annals of Internal medicine,* 125(10): 807-814.

8. Chiropractic Clinic Manual. 2010. Department of Chiropractic and Somatology, Durban University of Technology.

9. Cohen, S.P. 2005. Sacroiliac joint pain: A comprehensive review of anatomy, diagnosis and treatment. *Anesthesia and Analgesia*, 101: 1440-1453.

10. Dunn, K.M. and Croft, P.R. 2004. Classification of low back pain in primary care: Using “bothersomeness” to identify the most severe cases. *Spine,* 30(16): 1887-1892.

11. Esterhuizen, T. (glenhome@ensignship.com), 7 August 2010. *Chiro research.* E-mail to S.L. M^{c}Phail (sarahmcphail2@gmail.com) [Accessed 7 August 2010].

12. Esterhuizen, T. (esterhuizent@ukzn.ac.za), 28 January 2011. *Stats.* E-mail to S.L. M^{c}Phail (sarahmcphail2@gmail.com) [Accessed 28 January 2011].

13. Gronblad, M., Korkala, O., Konttinen, Y.T., Nederstrom, A., Hukkenen, M., Tolvanen, E. and Polak, J.M. 1991. Silver impregnation and immunohistochemical study of nerves in lumbar facet joint plical tissue. *Spine,* 16(1): 34-38.

14. Guebert, G.M., Rowe, L.T., Yochum, T.R., Thompson, J.R. and Maola, C.J. 2005. Congenital anomalies and normal skeletal variants. In Yochum, T.R. and Rowe, L.J. *Yochum and Rowe’s Essentials of Skeletal Radiology.* 3rd ed. Baltimore: Lippincott Williams & Wilkins.

15. Haldeman, S. (ed.) 2005. *Principles and Practice of Chiropractic.* 3rd ed. USA: McGraw Hill.

16. Haldeman, S. 1999. Differential diagnosis of low back pain. In Kirkaldy-Willis, W.M. and Bernard, T.N. (ed.) *Managing Low Back Pain.* 4th ed. Pennsylvania: Churchill Livingstone.

17. Horal, J. 1969. The clinical appearance of low back disorders in the city of Gothenburg, Sweden: Comparison of incapacitated probands with matched controls. *Acta Orthopaedica Scandanavica, Supplementum* 1 - 109.

18. Hussar, A.E. and Guller, E.J. 1956. Correlation of pain and the roentgenographic findings of spondylosis. *American Journal of Medical Science, 518-527.*

19. Jarvik, J.G. and Deyo, R.A. 2002. Diagnostic evaluation of low back pain with emphasis on imaging. *Annals of Internal Medicine*, 137(7): 586-597.

20. Jensen, M.C., Brant-Zawadzki, M.N., Obuchowski, N., Modic, M.T., Malkasian, D. and Ross, J.S. 1994. Magnetic resonance imaging of the lumbar spine in people without back pain. *New England Journal of Medicine,* 331(2): 69-73.

21. Kent, P. and Keating, J. 2004. Do primary-care clinicians think that nonspecific low back pain is one condition? *Spine,* 29(9):1022-1031.

22. Kirkaldy-Willis, W.M. and Bernard, T.N. (ed.) 1999. *Managing Low Back Pain.* 4th ed. Pennsylvania: Churchill Livingstone.

23. Louw, Q.A., Morris, L.D. and Grimmer-Somers, K. 2007. The prevalence of low back pain in Africa: a systematic review. *BMC Musculoskeletal Disorders*, 8: 105.

24. Lumbreras, B., Gonzalez-Alvarez, I., Lorente, M., Calbo, J., Aranaz, J. and Hernandez-Aguado, I. 2010. Unexpected findings at imaging: predicting frequency in various types of studies. *European Journal of Radiology,* 74: 269-274.

25. Lutz, G.K., Butzlaff, M. and Schultz-Venrath, U. 2003. Looking back on back pain: trial and error of diagnoses in the 20th century. *Spine,* 28(16):1899-1905.

26. Malanga, G.A. and Chimes, G.P. 2008. Lumbosacral facet syndrome. Available at: http://emedicine.medscape.com/article/94871-overview [Accessed 3 January 2011].

27. Marriott, A., Newman, N.M., Gracovetsky, S.A., Richards, M.P. and Asselin, S.A. 1999. Improving the evaluation of benign low back pain. *Spine,* 24(10):952-960.

28. McCulloch, J.A. and Transfeldt, E.E. 1997. Classification of low back pain. In *Macnab's Backache.* 3rd ed. Baltimore: Williams & Wilkins.

29. Moffett. J. and McLean, S. 2006. The role of physiotherapy in the management of non-specific back pain and neck pain. *Rheumatology,* 45: 371-378.

30. Patel, A.T and Ogle, A.A. 2000. Diagnosis and management of acute low back pain. *American Family Physician,* 61: 1779-1786, 1789-1790.

31. Pederson, P., Nøddeskou, H. and Wejse, B. 1992. A pilot survey of diagnoses, radiographic and laboratory procedures encountered in European chiropractic practices. *European Journal of Chiropractic,* 40: 71-82.

32. Peterson, C. and Hsu, W. 2005. Indications for and use of x-rays. In Haldeman, S. (ed.) *Principles and Practice of Chiropractic.* 3rd ed. USA: McGraw Hill.

33. Phillips, R.B. 1992. Plain film radiology in chiropractic. *Journal of Manipulative and Physiological Therapeutics*, 15(1): 47-50.

34. Pillay, A. 2007. *The periodic prevalence of congenital thoracic and lumbar spine anomalies and the association between the literature reported clinical features of these anomalies with the subject's presenting clinical features.* M. Tech. Chiro. dissertation, Durban University of Technology.

35. Quon, J.A., Bernard, T.N., Burton, C.V. and Kirkaldy-Willis, W.M. 1999. The site and nature of the lesion. In Kirkaldy-Willis, W.M. and Bernard, T.N. (ed.) *Managing Low Back Pain.* 4th ed. Pennsylvania: Churchill Livingstone.

36. Royal, H.D., Siegal, B.A. and Murphy Jr, W.A. 1993. An incidental finding: A radiologist's perspective. *American Journal of Radiology*, 160: 237-240.

37. Scavone, J.G., Latshaw, R.F. and Rohrer, V. 1981. Use of lumbar spine films: statistical evaluation at a university teaching hospital. *Journal of the American Medical Association*, 246(10): 1105-1108.

38. Selim, A.J., Fincke, G., Ren, X.S., Deyo, R.A., Lee, A., Skinner, K. and Kazis, L. 2000. Patient characteristics and patterns of use for lumbar spine radiographs. *Spine,* 25(19): 2440-2444.

39. Sembrano, J.N. and Polly, D.W. 2008. How often is low back pain not coming from the back? *Spine,* 34(1): E27-E32.

40. Shanks, P. 1992. "Hey doc, why do we really need to take x-rays?" *Dynamic Chiropractic*, 10(25)

41. Sherman, R. 1986. Chiropractic x-ray rationale. *The Journal of the Canadian Chiropractic Association*, 30(1): 33-35.

42. Simmons, E.D., Guyer, R.D., Graham-Smith, A. and Herzog, R. 1995. Radiographic assessment for patients with low back pain. *Spine*, 20: 1839-1841.

43. Souza, T.A. 2009. *Differential Diagnosis and Management for the Chiropractor: Protocols and Algorithms.* 4th ed. London: Jones and Bartlett.

44. *Stedman's Medical Dictionary for the Health Professions and Nursing*. 2005. Baltimore: Lippincott Williams & Wilkins.

45. Suarez-Almazor, M.E., Belseck, E., Russell, A.S. and Mackel, J.V. 1997. Use of lumbar radiographs for the early diagnosis of low back pain: Proposed guidelines would increase utilization. *Journal of the American Medical Association*, 277(22): 1782-1786.

46. Thomas, N.W.M. 2004. Low-back pain, sciatica, cervical and lumbar spondylosis. *Surgery,* 22(2): 25-28.

47. Travell, J.G. and Simons, D.G. 1999. *Myofascial Pain and Dysfunction: The Trigger Point Manual.* 2nd ed. Philadelphia: Lippincott Williams & Wilkins.

48. Tooke, S.M.T and Huckell, C.B. 1995. A surgeon's perspective on spinal imaging. *Spine,* 9(1): 1-26.

49. van Tulder, M.W., Assendelft, W.J.J., Koes, B.W. and Bouter, L.M. 1997. Spinal radiographic findings and nonspecific low back pain: a systematic review of observational studies. *Spine,* 22(4): 427-434.

50. Yochum, T.R. and Rowe, L.J. 2005. *Yochum and Rowe's Essentials of Skeletal Radiology.* 3rd ed. Baltimore: Lippincott Williams & Wilkins.

51. Waalen, D.P., White, T.P. and Waalen, J.K. 1994. Demographic and clinical characteristics of chiropractic patients: a five year study of patients treated at the Canadian Memorial Chiropractic College. *The Journal of the Canadian Chiropractic Association*, 38(2): 75-82.

APPENDIX A: DATA SHEET

Code		**Age**		**Gender**		**Ethnicity**	

Main complaint **Date of initial consultation**	
Clinical diagnosis/ differential diagnosis	

Treatment before x-rays					
Manual therapy	Electrotherapy	Soft tissue therapy	Stretching or strengthening	Referral	Other

Reason for x-ray referral (suspected diagnosis) **Date of x-rays** **Treatment number**	
Radiological diagnosis	
Incidental findings on x-ray	

Change in clinical diagnosis after x-rays?	Yes	No
New diagnosis		
Change in treatment after x-rays?	Yes	No

New treatment after x-rays					
Manual therapy	Electrotherapy	Soft tissue therapy	Stretching or strengthening	Referral	Other

APPENDIX B: PATIENT CONFIDENTIALITY CODING SHEET

Patient name	Date of birth	File number	Code

APPENDIX C: ETHICS CLEARANCE CERTIFICATE

DURBAN UNIVERSITY of TECHNOLOGY

Faculty of Health Sciences

ETHICS CLEARANCE CERTIFICATE

Student Name	Sarah McPhail	**Student No**	20431056
Ethics Reference Number	038/10	**Date of FRC Approval**	16/08/2010
Qualification	**Mtech Chiropractic**		
Research Title:	The role of lumbar spine x-rays in the diagnosis and management of patients who present with low back pain.		

In terms of the ethical considerations for the conduct of research in the Faculty of Health Sciences, Durban University of Technology, this proposal meets with Institutional requirements and confirms the following ethical obligations:

1. The researcher has read and understood the research ethics policy and procedures as endorsed by the Durban University of Technology, has sufficiently answered all questions pertaining to ethics in the DUT 186 and agrees to comply with them.
2. The researcher will report any serious adverse events pertaining to the research to the Faculty of Health Sciences Research Ethics Committee.
3. The researcher will submit any major additions or changes to the research proposal after approval has been granted to the Faculty of Health Sciences Research Committee for consideration.
4. The researcher, with the supervisor and co-researchers will take full responsibility in ensuring that the protocol is adhered to.
5. ***The following section must be completed if the research involves human participants:***

	YES	NO	N/A
❖ Provision has been made to obtain informed consent of the participants	x		
❖ Potential psychological and physical risks have been considered and minimised			x
❖ Provision has been made to avoid undue intrusion with regard to participants and community	x		
❖ Rights of participants will be safe-guarded in relation to: - Measures for the protection of anonymity and the maintenance of Confidentiality.	x		
- Access to research information and findings.	x		
- Termination of involvement without compromise	x		
- Misleading promises regarding benefits of the research	x		

[redacted]